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Evaluation of Neonate Squirrel Monkeys Receiving Tritiated Water Throughout Gestation

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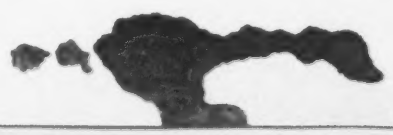

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16. ABSTRACT

The effect of receiving tritiated water (HTO) throughout gestation on the developing primate was assessed by administering HTO to adult female squirrel monkeys (Saimiri sciureus) as the only source of drinking water beginning with the day of insemination and continuing throughout pregnancy. For the control (tap water) and six experimental groups, the mean urinary tritium concentrations in females delivering full-term progeny were <0.004, 0.05, 0.16, 0.33, 0.75, 1.61, and 3.09 μCi/ml. Positive bioassays for pregnancy were observed in about half of 277 inseminated females. Among pregnant females, the full-term delivery rate was 36%, the abortion rate was 7%, and the resorption rate was 58% with no discernible effect of HTO administration on any of these parameters. The 46 full-term progeny were evaluated within 2 days of birth. No effects of HTO administration were observed in terms of gestation period (median 153 days, range 141-158 days), sex distribution, body weight, body dimensions, selected organ weights, histology (except gonads), or hematologic pattern. The number of primary oocytes in female progeny decreased markedly within increasing concentrations of tritium. Specific quantification of this effect and evaluation of the neonate testes is in progress.

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EVALUATION OF NEONATE SQUIRREL MONKEYS RECEIVING TRITIATED WATER THROUGHOUT GESTATION

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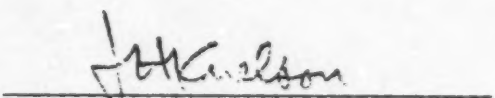
This report has been reviewed by the Health Effects Research Laboratory, U.S. Environmental Protection Agency, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the U.S. Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

FOREWORD

The many benefits of our modern, developing, industrial society are accompanied by certain hazards. Careful assessment of the relative risk of existing and new man-made environmental hazards is necessary for the establishment of sound regulatory policy. These regulations serve to enhance the quality of our environment in order to promote the public health and welfare and the productive capacity of our Nation's population.

The Health Effects Research Laboratory, Research Triangle Park, conducts a coordinated environmental health research program in toxicology, epidemiology, and clinical studies using human volunteer subjects. These studies address problems in air pollution, non-ionizing radiation, environmental carcinogenesis and the toxicology of pesticides as well as other chemical pollutants. The Laboratory develops and revises air quality criteria documents on pollutants for which national ambient air quality standards exist or are proposed, provides the data for registration of new pesticides or proposed suspension of those already in use, conducts research on hazardous and toxic materials, and is preparing the health basis for non-ionizing radiation standards. Direct support to the regulatory function of the Agency is provided in the form of expert testimony and preparation of affidavits as well as expert advice to the Administrator to assure the adequacy of health care and surveillance of persons having suffered imminent and substantial endangerment of their health.

This particular project was conducted to assess the effects of continuous low-level intrauterine exposure of subhuman primates to an energy-related pollutant.



John H. Knelson, M.D.
Director,
Health Effects Research Laboratory

PREFACE

The diversity of disciplines and efforts required for this project are reflected by the scientific and technical personnel who contributed their talents and dedication. The procurement and maintenance of the animals were directed by Samuel J. Jackson, D.V.M., who was assisted by his Animal Care Services Staff, particularly Richard V. Romero, Arthel Coleman, and Clarence Rhodes. Evaluation of reproductive cycle, breeding, and pregnancy testing were directed by Roger A. Barth, D.V.M., and Sidney J. Stolzenberg, Ph.D., with assistance from Shirley M. Madan, Deborah K. Palmer, and Victoria E. Gorum. John S. Krebs, Ph.D., supervised the preparation and administration of the tritiated water. Chozo Mitoma, Ph.D., directed the assays of the tritiated water and of the animal tissues and urine for radioactivity; he was assisted by Thomas Steeger and Jeanne Kalivoda. Daniel P. Sasmore, D.V.M., assisted by Sandra J. Phillips and Barbara A. Kirkhart, was responsible for necropsy, histology, and diagnosis of tissues. Joel N. Kaplan, Ph.D., generously advised on animal maintenance and breeding strategies. In addition to the SRI staff participants, R. Lowry Dobson, M.D., of the U.C. Lawrence Livermore Laboratory contributed invaluable advice on the interpretation of the histology of the ovary.

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INTRODUCTION

The objective of this project was to provide information that would be pertinent to evaluating the hazards to the general population of tritiated water (HTO) in the drinking water supplies. This situation could arise during the reprocessing of nuclear fuel and the mixing of processing waste streams with rivers providing drinking water to cities and, to a lesser extent, from the production of HTO in nuclear reactors and release to the environment.

Because previous studies with rats had shown that delayed reflex development and hypoactivity were induced by exposure to low levels of radiation from conception throughout life,[1] the squirrel monkey (Saimiri sciureus) was selected as the test animal in which to evaluate the potential HTO hazard in primates using, primarily, behavioral indices of effect. Drinking water levels were to range from about 16 to 1300 times the accepted permissible concentration (0.003 μCi/ml) in drinking water for the general population;[2] these concentrations were to be administered to pregnant female squirrel monkeys from conception to either birth or weaning of their progeny.

After the project had proceeded into the stage of administering HTO to inseminated monkeys, the primary focus of assessing the effects was changed from evaluating alterations in behavioral development of the progeny during the first postnatal year to conducting a physical and histologic evaluation of the progeny at birth. Criteria included gross and microscopic pathologic effects, body conformation and organ weights, and tissue distribution of radioactivity in the progeny and reproductive parameters in the inseminated adults. Still later certain ancillary studies were incorporated that involved specialized brain histology procedures and evaluation of ovarian changes in the progeny by estimating the total primary oocyte count. The latter studies, being conducted at other laboratories, have not yet been completed, so only preliminary results for these evaluations can be presented at this time. The primary studies, conducted entirely at SRI, have been completed and form the basis for this final report.

SUMMARY AND CONCLUSIONS

The proportion of squirrel monkeys bred under the conditions of this study expected to deliver full-term progeny was overestimated by a factor of two to three. Both the proportion of inseminated animals that actually conceived and the proportion of pregnant animals that provided full-term progeny were lower than expected. In addition, the ratio of the HTO concentration in body water to that in drinking water was lower than expected for the squirrel monkey, so that body water concentrations were about 75% of the initially scheduled levels. Despite these differences from the initial design parameters, several conclusions about the effects of HTO administration during gestation appear to be valid.

The present data indicate no discernible anatomic or physiologic effects on the neonate squirrel monkey of HTO administeration to the mother throughout gestation in drinking water at levels ranging from 16 to 1,000 times the permissible level for consumption (0.003 μCi/ml). The neonate monkeys were unaffected in terms of the following criteria:

- Body weight
- Selected body dimensions
- Selected organ weights
- Hematologic patterns
- Histology of selected organs and tissues other than ovaries.

The number of primary oocytes in female neonate squirrel monkeys apparently decreased markedly with increasing levels of HTO in the drinking water during gestation. The need for quantifying this effort was not foreseen in planning this project, and the appropriate technique is laborious and exacting. Nonetheless, neonate ovaries are being processed and evaluated by a collaborator (Dr. R. L. Dobson, U.C. Lawrence Livermore Laboratory), who expects the results will be available within 3 months.

Based on the following criteria, HTO administered at the levels specified either throughout pregnancy or, in the case of animals not delivering full-term progeny, for the equivalent time (about 22 weeks) had no discernible effect on inseminated adult squirrel monkeys:

- Abortion and/or resorption rate
- Gestation period
- Body weight.

The effect of HTO administration on the number of primary oocytes in the adult female squirrel monkey is not known. Unilateral ovariectomies were performed on a total of 56 females from the controls and the four highest dose groups; these tissues are now being processed for oocyte counting by Dr. Dobson. Because the time requirements for this effort are even greater than those for evaluating neonate ovaries and because present resources are limited, these results will not be available until about a year from now.

Certain information not pertaining to the effects of HTO administration was also generated from this project. Timed-pregnant squirrel monkeys can be provided from a nonhabituated animal population wherein the social structure of the breeding groups is not strongly stabilized; however, the full-term delivery rate may be reduced as compared with more conventional breeding practices. Identification of inseminated animals using the presence of a vaginal plug as the criterion and identification of pregnant animals using the mouse uterus weight procedure yield essentially no false negatives and the former is a much less time-consuming procedure than vaginal slide preparation and examination. The insemination rate falls markedly at the beginning of the second week of continuous breeding and becomes very low after the second week. With the present procedures, both the pregnancy rate of those inseminated and the resorption rate of those pregnant were of the order of 50%. For squirrel monkeys of Bolivian origin, the gestation period appears to be between 141 and 159 days, with a mean of 152.5 days (S.D., 3.9 days).

RECOMMENDATIONS

1. Upon completion of the evaluation of the quantitative data on oocyte counts in the neonate squirrel monkeys, the pertinence of this information to the potential hazard to human population of HTO in drinking water should be assessed.

2. Similar considerations should be made after the quantitative oocyte data for the adult squirrel monkeys have been evaluated.

3. The need for further studies involving HTO administration to primates to resolve questions arising in the above evaluations should be considered.

4. A means for following the future reproductive performance of the adult females exposed to HTO at SRI and now being held at the Caribbean Primate Research Center should be implemented as soon as possible.

PROCEDURES AND RESULTS

Animals and Breeding Procedures

Although most squirrel monkeys (Saimiri sciureus) used in research in the United States come from Columbia or Peru, Bolivia was the only source that had a sufficient number of adult female monkeys for this project at the time of its initiation. Accordingly, arrangements were made with a commercial importing company* to provide a total of 400 adult females from that country. Only females with external indications (such as nipple development) of having previously delivered offspring were accepted. This large number of females was considered necessary because the objective was to provide at least 100 viable 6-month-old progeny, and loss rates due to failure to become inseminated, failure to maintain pregnancy, and/or to infant mortality can be high, particularly in unacclimated, newly imported animals. In addition to the 400 females (ten cohorts of about 20 to 50 each), 40 adult males were also acquired from the same source.

After the usual 5-week quarantine, the females were assigned to groups of 15, and each group occupied a concrete-floored wire-mesh run (1.2 m × 2.4 m × 2.3 m). The males were housed similarly, but separately, before breeding. For this report, breeding means only that males and females were accessible to each other. Tap water was supplied ad libitum via automatic drinking valves. Vitamin supplement† was provided in 1-liter drinking bottles twice a week. Feed‡ was supplied twice a day. The floors of the pen were hosed daily with tap water.

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*Primate Imports, New York.

†Tang®, General Foods Corp., and Visorbin®, Norden Laboratories.

‡Monkey Chow 25, Ralston Purina Co.

The squirrel monkey has a 5- to 14-day reproduction cycle that continues for about 3 months; the particular time of year of the cycle varies according to geographic latitude and length of time of residence at a particular latitude. Once some females in a given colony begin their cycle, the proportion of the females in cycle increases rapidly. The method for evaluating the reproductive state depends on the presence of nucleated epithelial cells and/or cornified cells in vaginal washings, these cells being indicators of the occurrence of cycling. A pipette containing physiologic saline is inserted into the vagina, the solution is rinsed in and out, and an aliquot is transferred to a microcell for reading at 400 × magnification. In the case of breeding animals, the presence of sperm in the slide indicates insemination. Some females of the first cohort were assessed daily for cycling as soon as they had completed quarantine in late April. Some of them were found to be in cycle, and, by the time that a sufficient number of animals had become available to begin breeding (late May), all the animals were in cycle.

During the cycling evaluation, which continued for about a month as a means of evaluating for insemination, we discovered that over 90% of the females showing sperm in the vaginal washings also had a seminal coagulum or plug in the vagina, detectable visually or by observing the flow characteristics of the wash fluid during vaginal rinsing. Because detection of plugs was much more efficient in terms of technician time, insemination was defined as the presence of a plug, and the preparation of vaginal slides was discontinued.

An important objective of the breeding effort was to identify inseminated monkeys within 24 hours of insemination so that HTO administration could commence essentially coincident with conception. For economy of operations, accurate recognition of insemination was important. Inaccuracy could have resulted in beginning HTO administration to uninseminated monkeys or in identifying inseminated animals at a later date, thus delaying HTO reception until significantly later in gestation. In the squirrel monkey, subsequent insemination can occur many days after conception. Because of this explicit need to initiate HTO administration

at conception, personnel had to be available to detect insemination in every breeding female within 24 hours of possible insemination. Because the same personnel were also conducting the pregnancy evaluations in already inseminated animals, and because we realized that ultimate evaluation of progeny would be more efficient with a consistent birth schedule as opposed to a sudden wave of births, the breeding schedule was adjusted accordingly.

Initially, some females were placed in individual cages one-to-one with a male, but this method appeared to yield no more inseminations than did a breeding unit consisting of 15 females and 3 males in a pen. As the project progressed, inseminated females were removed for HTO administration and either naive females were added to the breeding pens or groups were combined to maintain an efficient group size. As pregnancy testing became a major effort, breeding was interrupted whenever personnel were unavailable to check for insemination within 24 hours. Thus, the precise breeding history varied among animals.

Of the 406 females received, 373 were bred. The remaining 33 were found dead before breeding (N = 10), were immature (N = 14), were pregnant upon arrival (N = 2), were injured during their scheduled breeding period (N = 3), or were not permitted to breed through oversight (N = 4). Of the 373 animals bred, 277 (74%) were inseminated. Of these, 242 were inseminated as a result of continuous breeding, and the remaining 35 were inseminated through intermittent breeding. The 96 noninseminated animals were bred for a median of 23 days (range, 2 to 46 days) without detectable insemination. None of these animals either delivered or aborted within the possible gestation period since the last breeding day. For the animals inseminated during continuous breeding, the median time to achieve insemination was 5 days, with 25% of the monkeys inseminated within 2 days and 75% within 8 days. Sporadic peaks occurred in the daily insemination rate (proportion of the animals still in the breeding situation that were inseminated) during the next 10 days, and one animal was inseminated after 37 continuous days of breeding. However, the probability of insemination clearly became much lower after about 2 weeks.

Administration of HTO

Three shipments of high specific activity HTO were acquired from two suppliers: in May* 1 Ci and 7 Ci in May and 3 Ci in October.† Stock solutions were prepared by successive dilution, and appropriate aliquots of the stock were transferred to capped vials for final dilution with tap water. Aliquots of the stock solutions were diluted with physiological saline in sterile serum bottles for initial injections into inseminated monkeys. The objective was to bring the concentration of HTO in the body water rapidly up to the desired level by means of intraperitoneal (ip) injection on the day of insemination and then maintain it throughout gestation by administration in the drinking water.

The desired body water HTO concentrations were 0 (control), 0.05, 0.2, 0.5, 1.0, 2.0, and 4.0 μCi/ml for the seven groups. Calculation of the microcuries to be injected initially was based on the average weight of a sample of the animals at that time (660 g) and on an estimated mean total body water content of 455 ml (weight × 0.69). Initial scheduled concentrations for administration of HTO in the drinking water were based on the estimate that the body water HTO concentration would approximate 83% of the drinking water concentration. Radioassay during the first few weeks of administration indicated that the actual HTO concentrations in the drinking water were lower than expected, apparently because the initial 1-Ci shipment was mislabeled. Accordingly, scheduled drinking water concentrations were increased after the fourth week. During the next 2 weeks, by which time sufficient urine samples were available for a more precise evaluation, the initial estimate of the urine-to-drinking water ratio of 83% was found to be too high, even with large variabilities in urine radioactivity both within and between groups. Thus, the scheduled HTO concentration in drinking water was increased again at the end of the sixth week.

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*New England Nuclear Co.

†Amersham-Searle Co.

The lower-than-expected concentrations of HTO in body water appeared to be related primarily to a combination of maintenance procedures and squirrel monkey behavior. After food pellets were put into the hopper, the monkeys began eating, holding a pellet in the forepaws and frequently dropping it on the floor. About an hour later, the animal technician sprayed the floors of the pens to presoak the accumulated food debris and excreta and then returned later to hose the floors clean. In the interim between soaking and hosing (about a half-hour), the monkeys had access to tap-water-soaked pellet debris. Thus, total water intake included a variable fraction of nontritiated water. This probably accounts for the initial underestimate of the body water-to-drinking water ratio and also probably contributed significantly to the observed variability within and between animals. Table 1 summarizes the pertinent data.

On the day that insemination was detected, females were assigned to one of the seven groups (by use of a table of random numbers), received 1 ml of the appropriate HTO solution, and were transferred to a pen in another building where the appropriate concentration of HTO in the drinking water was available. Animal maintenance procedures and the pen dimensions were as described above. Tritiated drinking water was prepared initially by rinsing one of the stock solution vials into a 25-liter polyethylene carboy, diluting with tap water, and mixing by rotation. Water from the carboy was withdrawn into 1-liter glass bottles with conventional stainless-steel drinking stems, which were then fastened to the cyclone-wire pen doors. Controls received tap water in similar bottles. As the number of inseminated monkeys increased, about 60 bottles were required per week. Because of the many hours spent handling bottles and because of the associated potentially large error possibilities, the HTO administration system was converted to 20-liter tanks fastened directly to the pen doors, with a drinking valve on the inside of the cage. Controls drank tap water from a drinking valve attached directly to the tap water supply pipe. Each of the 20-liter tanks was calibrated and marked at 5-liter intervals, and the stock HTO vials were rinsed directly into the tanks and diluted with a high-pressure hose fitting so

that mixing was accomplished through churning. Twice weekly, vitamin supplements were supplied in 1-liter bottles by dissolving the supplement in HTO drawn from the appropriate tank.

The radioactivity of drinking water was determined on duplicate aliquots of 0.1 ml in a liquid scintillation system.* Quench compensation was made by automatically obtaining external standard pulse height (ESP values) for each sample. The ESP values were used to correct the count of the colored sample to that of the unquenched sample by reference to a standard curve obtained by plotting the degree of quench as a function of ESP values. All samples were counted in polyethylene vials.† The tritiated water standard was counted each time to calculate the counting efficiency. The efficiency varied between 46.5 and 56.8%, with a mean of 50.8 and a standard deviation of 2.3%. The variation in the counting efficiency is partly a function of the scintillation fluid used.‡

Table 2 presents the results. The missing entries for the weeks of 7/9, 7/16, 8/13-8/27, and 9/3 were associated with changes in the operation schedule. The sample from Group 2 for 10/8 was not assayed by error. Only animals in Groups 2 and 3 were still receiving HTO during the last week. The changes in scheduled HTO concentration noted above are reflected in the lower values during the first 6 weeks. Beginning with the week of 7/23, the mean HTO concentrations were within 5% of the scheduled values (Table 1), and almost all values were within one standard deviation of the mean. Standard deviations increased with increasing HTO concentration and ranged from 4 to 13% of the mean.

---

*Searle Analytic, Inc., Mark III.

†Packard Instrument Company, Inc.

‡New England Nuclear's Oxifluor-H_2O™ was used first, but later Aquasol was used because it gave a slightly higher efficiency.

Evaluation of Pregnancy

Evaluation for pregnancy in inseminated monkeys comprised three objectives. The first was to provide a means for selection in case replacing an inseminated but nonpregnant animal with another subsequently inseminated monkey was necessary because of space limitations in the pens reserved for HTO administration. Second, pregnancy evaluation was to provide data on the rate of resorption* as a function of HTO dose level, if such a relationship existed. Third, pregnancy evaluation was to provide a check on the adequacy of insemination, as defined above, and on the breeding regimen.

The bioassay method used for pregnancy determination was essentially similar to the methods customarily used,[3,4] but it was slightly modified so that large numbers of assays could be performed. An aliquot of each of the 24-hour urine samples collected for HTO assay from the inseminated monkeys was used for pregnancy assay. Three 10- to 12-g female mice were injected ip once daily for 3 days with 0.3 ml of the urine. One control group of mice received 0.3 ml of physiological saline injected ip, and a second control group of mice received no treatment for each set of urine samples tested. On the fourth day, all mice were killed by cervical dislocation, and the uteri were removed, stripped of fat and connective tissue, pressed on a paper towel to remove luminal fluid, and weighed to the nearest 0.2 mg on a torsion balance.†

To avoid discarding pregnant monkeys from the study, we initially considered that a 33% increase in the uterine weight of urine-treated mice over that of control mice indicated pregnancy. This was based on criteria used by Wilson and Fradkin[4] who injected monkey serum into five mice. Ultimately, we found that a 100% increase in uterine weight of urine-treated over control mice was a better index of pregnancy in our study and used this as the criterion of a positive pregnancy test.

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*Resorption is used in this report to distinguish an animal that was positive on the pregnancy test but failed to provide either frank evidence of abortion (fetal, or placental material, vaginal bleeding) or a full-term delivery.

†Roller-Smith.

In some cases, no reliable result was obtained either because of insufficient urine or because the urine was toxic to the mice, presumably because of contamination by food and/or feces in the collection system, although even urine that appeared clean was occasionally toxic. Weekly samples were available for most animals, however, and Table 3 shows the data for all animals evaluated. These data indicate that about half of the inseminated monkeys had conceived and that resorption or frank abortion occurred in over half of the pregnant monkeys. The major portion (70 of 78) of the total abortions were resorptions. Because pregnancy testing generally did not continue past the sixth week postinsemination, we cannot specify when resorptions tended to occur for these 70 animals. For the 10 animals in which gross signs were apparent, the abortions occurred between 78 and 129 days postinsemination.

Body Weight

Inseminated animals were weighed at approximately 4-week intervals during the period of HTO administration. Because of the introduction of animals to each dose group as they became inseminated, the number of animals weighed during any particular week varied. For most of the experiment, two dose groups were weighed each week (one on Monday or Tuesday, the other on Wednesday or Thursday) just before being placed in metabolic cages for urine collection. Because seven groups were used, only the controls were weighed during the fourth week of the weighing cycle. As the experiment progressed, the precise weighing schedule was varied somewhat according to staff availability, so that in some cases some animals were weighed twice within 4 weeks and were not weighed during the next 4-week interval.

Body weight obviously is affected by pregnancy, particularly after the first trimester. Table 4 presents the data for animals that did not provide full-term deliveries or evidence of frank abortion and Table 5 presents the data for those that did produce full-term progeny. These data in Table 4 indicate that body weights in the squirrel monkey are somewhat variable. Inspection of data for individual animals reveals

changes in body weight of as great as 10% on successive 4-week weighings; these changes may be either loss or gain. Analysis of variance showed significant ($p < 0.05$) differences among the seven groups at all time intervals except the fourth (Weeks 13 through 16); but corresponding differences among the six HTO groups were apparent only during the first time interval (Weeks 1 through 4). Further, no dose-response relationship was apparent between body weight and HTO level among the six HTO groups. Thus, although the control group weighed more than the groups receiving HTO after the first 8 weeks, this relationship probably was not associated with the HTO, unless some phenomenon independent of the concentration of HTO occurred. For example, one possibility is that HTO administered within the specified range of concentration has a taste that is less acceptable than that of ordinary tap water. However, three other factors distinguished the control group from the six HTO groups: (1) the control pens were on the end of the two rows of seven pens in which inseminated animals were housed; (2) HTO-receiving animals drank fluid stored in polyethylene containers whereas the controls drank directly from the tap-water pipes; (3) although the drinking valves were identical for all seven groups, the valves supplying water for the controls were about 25 cm above the pen floor, whereas those for the HTO groups were about 100 cm above the floor. The decision not to use the polyethelene tanks for controls was based on physical arrangements: tanks on the outside of the end pens would have interfered markedly with access to the corridors through which personnel and equipment moved. The height difference was thought to be unimportant, since no decrements in the agility or activity of the monkeys associated with HTO were observed. Nonetheless, exploring the palatability of HTO as compared with that of ordinary tap water would be of interest in a future study on this species.

The body weight data for full-term pregnant females (Table 5) were subjected to analysis of variance, and no differences ($p < 0.05$) among the means for the seven groups were apparent. For evaluation of the effects of full-term pregnancy on body weight, the individual data were adjusted so that birth was allotted to Week 22, and the pooled (across

dose groups) data were compared with the pooled postinsemination data for the animals that did not deliver or abort; Figure 1 shows these results. Because only a few full-term animals were weighed during the first 3 weeks of pregnancy, the apparently lower mean weights during that period for full-term mothers may not be significant. Clearly, from about the sixth week, the mean body weight for full-term animals exceeded that for the remaining animals, reaching values about 16% higher from Week 15 until birth. Because of variability, however, increase in body weight does not appear to be a useful criterion of pregnancy, since by the time that significant weight excess would be reliably apparent (Week 15), palpation and/or visible abdominal enlargement already would have established pregnancy.

Births

Table 6 shows the time distribution of the 46 full-term* progeny. Although comparable numbers of inseminated females were in each of the dose groups, the number of full-term progeny varied markedly, with no consistent dose dependency discernible. The sex distribution among all 46 progeny was not remarkable; but all 4 of the Group 4 progeny were male, and all 8 of the Group 7 progeny were female. Median and mean times from insemination to birth were consistent among all groups. Thus, these data indicate no clear effect of HTO administration on apparent gestation period, sex distribution among progeny, or proportion of inseminated animals delivering full-term progeny.

Precise data for estimating the gestation period in the Bolivian squirrel monkey are not available in the literature. In the present study, however, the individual breeding histories are known, and they provide a means for evaluating the range of possible gestation periods for each of the animals. They also provide evidence for evaluating the accuracy of the insemination criteria used and some information about breeding behavior. Table 7 shows these data. Single entries in the first column

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*Completeness of hair covering and easy eyelid retraction were the criteria establishing full-term status.

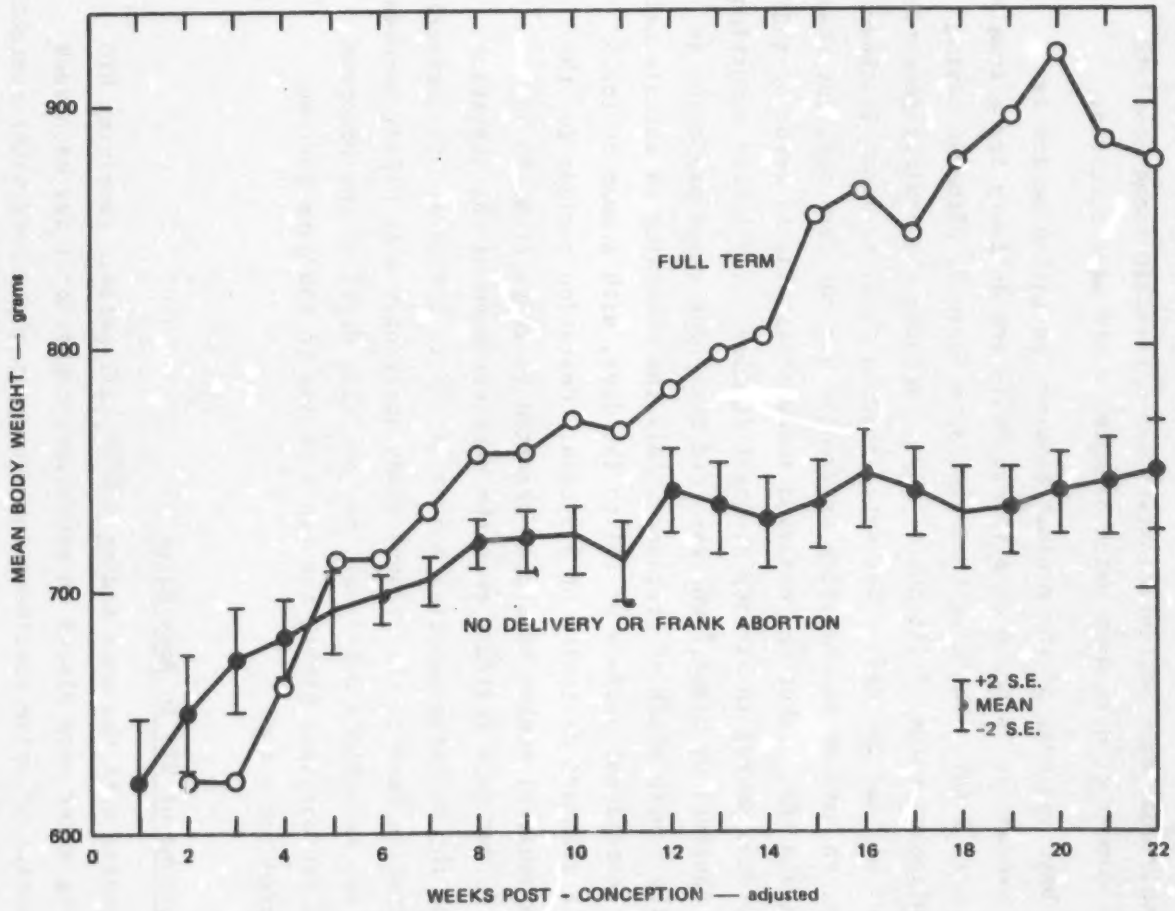

FIGURE 1 COMPARISON OF POOLED BODY WEIGHT DATA FOR FULL-TERM PREGNANT FEMALES WITH THOSE FOR THE REMAINING INSEMINATED ANIMALS

identify animals that were bred continuously for the specified number of days before insemination. Composite numbers indicate the number of days for each segment of intermittent breeding, with the numbers in parentheses indicating the number of days between breeding periods. Thus, each of the individual days postinsemination has a possible range equal to the total number of days over which breeding could have occurred.

The best estimate of the minimum observed gestation period is 141 days because it is based on a viable full-term delivery for a female bred for only 1 day. The last two animals in Table 7, although having postinsemination times of 136 and 87 days, had possible maximum gestation periods of 151 and 157 days. The data indicate that, at least in these two cases, an earlier insemination apparently was not detected, but they also indicate that either the observed insemination was in error or that insemination occurred in already pregnant females. The latter situation has been observed by Clewe,[5] who reported that copulation may occur as late as the fourth month of pregnancy. All the remaining 44 animals had observed gestational periods of 141 to 159 days, with a mean of 152.5 days and a standard deviation of 3.9 days. Gestation periods for the Colombian squirrel monkey have been reported to range from 168 to 172 days.[6] Our data indicate that the best estimate of the gestation period for the Bolivian squirrel monkey is 141 to 158 days. The criteria of insemination used in the present study apparently were valid, because--with the two exceptions noted--all but one (159 days) of the observed gestation periods were within the range of 141 to 158 days for the animals bred for 1 day.

Concentrations of HTO in Body Water

Beginning with the week ending 6/4/76, all animals receiving HTO in drinking water were placed in metabolism cages for 1 day each week for collection of urine specimens for determining the body water content of HTO and evaluating pregnancy. Animals were placed in the cages between 2 and 3 p.m. and were removed between 10 and 11 a.m. the following morning. Two groups were placed in the metabolism cages each day Monday through

Wednesday, and the seventh group (controls) was placed in the metabolism cages on Thursday. The cages were washed, dried, and prepared for the next groups of animals during the interval between 11 a.m. and 2 p.m. While in the metabolism cages, the animals received HTO ad libitum from the same water stock provided for them in their home pens. Initially, food pellets were supplied; but, after the first few collections, we found that the urine samples were contaminated extensively with food debris, so food was withheld during the period in the metabolism cage.

Beginning with the week of 8/13/76, the schedule was changed to a 4-week cycle for placing animals in metabolism cages, with two groups being put in the cages each week for 3 weeks, and the seventh group (the controls) being put in them during the fourth week. No other aspects of the procedure were changed.

Urine excreted by the monkeys was collected in stainless-steel trays, from which it drained into wide-mouth glass jars. After the monkeys were removed in the morning, aliquots of the urine were decanted from the jars into capped plastic tubes for assay of HTO content, and a second aliquot was decanted for pregnancy assay. The results of the radioactivity assay were tabulated by animal identification number and week of collection. Usable urine specimens could not be obtained from all animals at each collection time. In some cases, the volume of urine was so small that it dried or was adsorbed on debris in the collecting tray; in a few cases, the animal appeared not to have urinated during the confinement in the metabolism cage. Because of the large number of animals being handled, and the policy of keeping handling of potentially pregnant animals to a minimum, the lack of urine specimens in a given week from some of the animals was accepted as unavoidable, and no attempt was made to collect additional specimens.

Table 8 summarizes results of the urine assays for HTO in animals receiving HTO in the drinking water. The data are mean concentrations of HTO in all animals of each group, listed by week of study. HTO concentrations were lower during the first 6 weeks of the study, before the final adjustment of HTO concentration in the drinking water. During the period

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after the final adjustment, the overall concentration of HTO in the urine of each group was of the order of 80 to 90% of that originally intended by the experimental protocol. However, the mean concentrations of HTO in urine varied greatly from one week to the next in all groups, and the standard deviations of concentration within each group for each week were high, ranging up to as much as 40% of the mean.

Table 9 shows the data for assays of urine from the control animals (Group 1). These animals were not given HTO but were supplied with drinking water from drinking valves attached to the building water supply. They were housed in the same building as the experimental animals. Beginning with the fourth week of the study, HTO was detected in the urine of these animals, and from 7/16 through 11/26 the overall concentration of HTO in the urine was of the order of 9 to 10% of that in the urine of Group 2 animals. The only possible source of HTO for these animals was the HTO in the ambient air in the animal compound; this HTO presumably came from expiration and from evaporation of water and urine from the other pens in the compound.

Tables 10 through 16 summarize the individual measurements of HTO concentration in urine for all the animals that delivered full-term infants in Groups 1 through 7, respectively. Blanks in the tables indicate weeks during which samples of urine were not obtained from the individual animals.

We examined the data on concentration of HTO in urine to determine whether pregnancy had any effect on the HTO concentration in body water. The method used was to compute an overall mean and standard deviation for all animals that delivered infants (including not-full-term infants) and for all other animals in each experimental group except Group 1. Table 17 summarizes the results of the analysis. In five of the six groups, the HTO concentration was slightly higher in pregnant than in nonpregnant monkeys, ranging from 3 to 15%. The overall difference between pregnant and nonpregnant monkeys was 4.8%, and the results suggest the influence of pregnancy on the water balance but are of doubtful significance. A more refined analysis of the data, focusing on particular stages of pregnancy, might show stronger and more significant differences.

The concentrations of HTO in urine were generally proportional to those in the drinking water, but the variability was very high and the concentrations were inconsistent from week to week. Figure 2 illustrates the weekly variation in urine-to-drinking water ratios for Groups 2 and 7. The concentration ratios ranged from 0.46 to 0.68 and from 0.34 to 0.72 for Groups 7 and 2, respectively, and no systematic correlation could be established between the two groups. Standard deviations (shown for Group 7 only) were high. The results indicate that procedural physical or physiological factors other than concentration of HTO in drinking water strongly influenced the concentration of HTO in urine and body water.

The overall mean ratio of urine HTO concentration to that in drinking water was determined after completion of the experiment by computing the linear regression of the mean HTO concentrations in urine for all the groups at all weeks (Table 8) on the corresponding HTO concentrations in drinking water (Table 2). The completed regression analysis gave the equation:

$$\text{Urinary HTO} = (0.010 \pm 0.034) + (0.539 \pm 0.018)\ (\text{HTO in drinking water}) \quad .$$

The regression line extrapolated to zero at zero drinking water and showed that the overall average urinary-to-drinking water ratio for HTO was 0.539. This value is considerably less than that expected on the basis of studies with rats.[7]

Examination of the standard deviations of HTO concentration in various groups indicated that they tended to be proportional to the means of the groups. On the basis of this observation, the overall standard deviation for concentration of HTO in urine was estimated by computing the linear regression of the standard deviation on the mean for all the groups at all weeks of study. The resulting line extrapolated to zero standard deviation at zero mean HTO concentration and showed that the average standard deviation for concentration of HTO in urine was 25.2% of the mean. By using a similar procedure for successive duplicate samples of drinking water, we found that the standard deviation for the concentration of HTO in drinking water was 7.3% of the mean. The standard

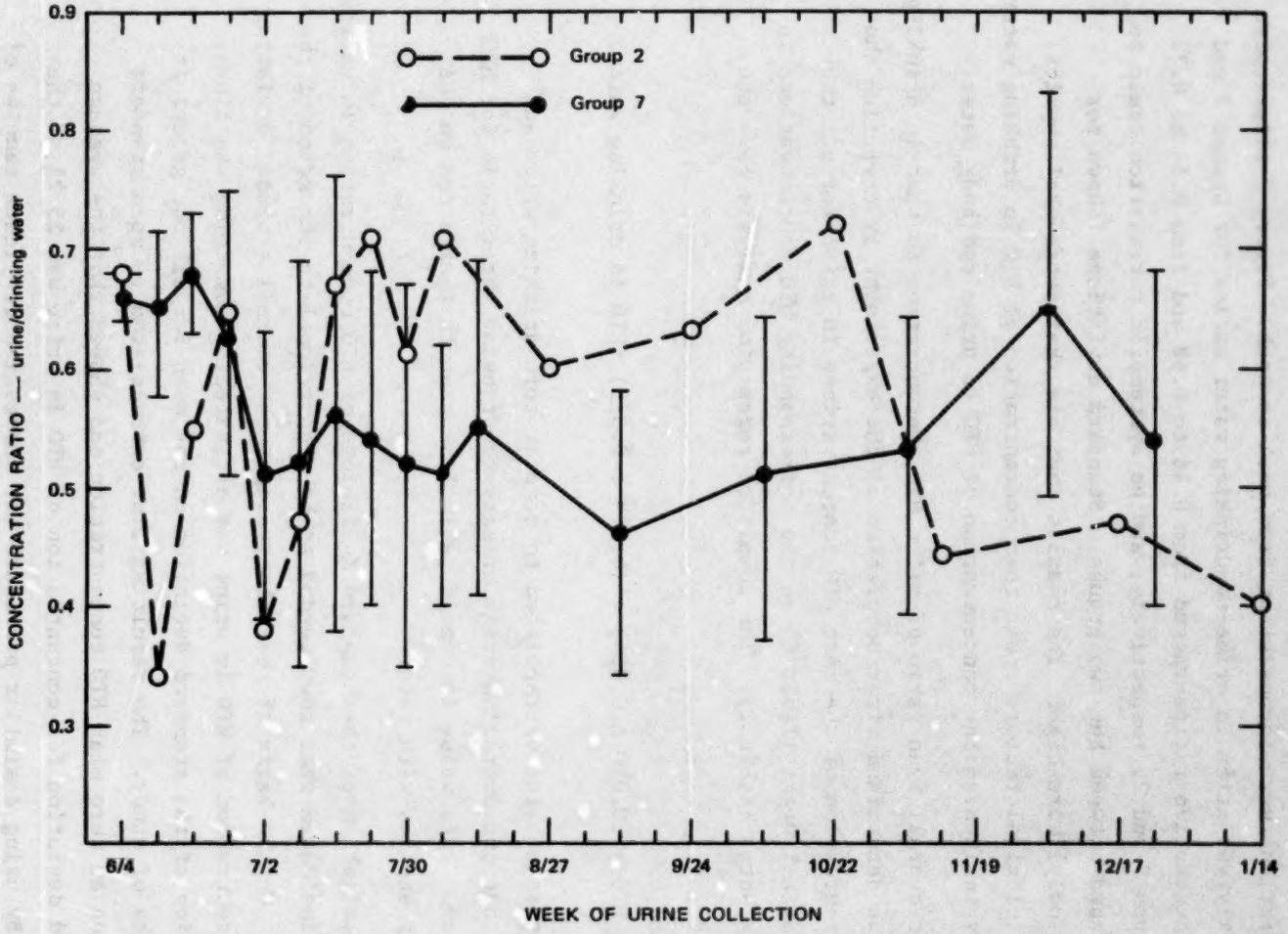


FIGURE 2 RELATIONSHIP BETWEEN URINE AND DRINKING WATER CONCENTRATIONS OF HTO IN ADULT FEMALE SQUIRREL MONKEYS OF GROUPS 2 AND 7

deviation for HTO concentration in drinking water represents the variability sources included in preparing and mixing the drinking water and determining its HTO content. The standard deviation for HTO concentration in urine represents all sources of variability. By subtracting the square of drinking water standard deviation from the square of urine standard deviation and by taking the square root of the result, we can estimate the standard deviation for the urinary concentration of HTO, exclusive of that contributed by the variability of the drinking water. The value of this reduced standard deviation was 24.1% of the mean and represented the variability of urinary concentration of HTO, as measured in this study, resulting from various causes including variations in animal individuality, feeding and drinking behavior, physiological state, current food and water consumption, and metabolic rate.

Assay of Radioactivity in Tissues

Samples of selected organs taken from the neonate monkeys at necropsy were kept frozen in plastic vials. Before homogenization, these samples were weighed on an analytical balance. The tissues were homogenized in an all-glass homogenizer* with at least three volumes (w/v) of distilled water. The final volume of each homogenate was recorded so that the volume could be related to the initial wet weight of the tissue. Quadruplicate aliquots (0.1 ml) of each homogenate were pipetted into polyethylene vials. The homogenate was decolorized by the addition of 0.1 ml of 30% hydrogen peroxide. After the samples had stood at ambient temperature for 15 to 20 minutes, 10 ml of scintillator fluid was added to each of two samples for immediate radioactivity assay. The other two samples were placed in an oven (temperature, 45 to 60° C) for overnight evaporation of moisture. The residue was treated with 1.0 ml of ethanol and dried again in the oven. The radioactivity in the dried samples was counted after addition of scintillator fluid, in the same manner as described above.

*Duall, Kontes Glass.

As shown in Tables 18 and 19, respectively, the counting data were expressed as microcuries per gram of wet tissue before and after removal of the moisture. The difference between these two sets of data is attributable to tritiated water in the tissue, and the radioactivity content in tissues after dehydration is taken to represent tritium fixed in the tissue by incorporation into tissue protein, carbohydrate, fat, or nucleic acid.

The dependency of organ tissue radioactivity (wet) on the HTO concentration in the drinking water, apparent from Tables 18 and 19, was subjected to linear regression analysis. We found a significant ($p < 0.05$) dependence of tissue radioactivity on HTO concentration and that the relationship fitted ($p < 0.05$) the linear regression model for each of the 11 organs and/or tissues. The calculated slopes and Y-intercept (estimated radioactivity at zero drinking water HTO concentration) are summarized in Table 20. The 95% confidence limits for the estimated zero concentration of HTO in the drinking water all include zero radioactivity. This indicates a linear relationship with no threshold; that is, no HTO concentration is apparent in drinking water where no radioactivity is discernible in the tissues.

Gross and Microscopic Evaluations of Progeny

Gross and histopathologic evaluations of the neonate squirrel monkeys were conducted according to the protocol specified in the contract with three exceptions: (1) omission of most of the SMAC-20 blood chemistries because of our inability to obtain adequate volumes of blood, (2) approximately one-half of the whole fixed brains were sent to EPA for future special detailed neuropathologic evaluation, and (3) parts of some brains and all ovaries and eyes were sent to the Lawrence Livermore Laboratory for future special evaluation. The necropsy procedure is outlined in Schedule 1. Forty-one full-term viable progeny, five full-term stillborn progeny, and four aborted fetuses were necropsied and examined. Formalin-fixed sections were processed to H&E slides, with the exceptions noted above.

Schedule 1

SQUIRREL MONKEY NECROPSY PROCEDURE

Prenecropsy Sequence

Clinical, behavior, activity
Bleed from heart:
  1 ml, CBC, Vacutainer
  1 ml, Rad Count, Vacutainer
  1-2 ml+ of Serum SMAC 20 (glass vial)
External examination for defects
Measurements
Weights, body and organ

Necropsy Sequence

Brain*
Pituitary
Eyes
Nasal cavity
Salivary gland and node
Larynx, trachea, esophagus
Skin and breast
Sternum
Thymus
Heart*
Lung
Diaphragm
Spleen*
Kidney*
Adrenal*
Ovaries/testes
Uterus/accessory gland
Urocyst (dilate)
Liver*
Stomach
Intestines
Mesenteric node
Sciatic nerve and muscle
Femur, crush for marrow
  touch preparation

Radiation Count, Vial Number

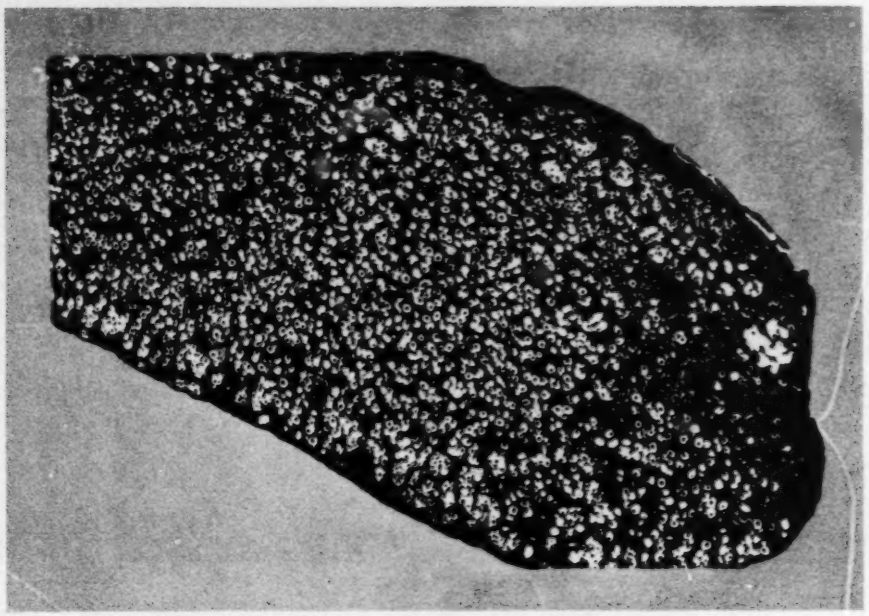
1	2	3
1/2 Brain	Muscle	1 Kidney
1/2 Liver	1/2 Heart	1 Adrenal
	Skin	1/2 Stomach
	1/2 Placenta	< 1/2 Spleen
		1" Duodenum

*Weigh these organs.

In five cases, gross lesions were observed at necropsy. One full-term viable infant had hemorrhage in the brain in the meninges, focally congested lungs, and an umbilical prolapse. Cerebral hemorrhage was noted in one full-term stillborn infant, and hemoperitoneum was observed in another. One aborted fetus had lacerations and contusions of the right foot and left occiput, and another had a contused frontal area on the skull. Most likely, these observations are related to postnatal trauma, particularly in the case of the latter four.

Of the six cases of frank abortion, congestion, extramedullary hematopoiesis, and lung atelectasis were the only microscopic observations. Table 21 lists the locations of the lesions observed in the 46 full-term viable and stillborn animals. Congestion was the diagnosis in over two-thirds of the lesions, and about one-fourth of the lesions observed were in the lung. No relationship between frequency of occurrence of lesions and HTO dose was apparent, with one exception. Unlike the rest of the neonate tissues examined histologically (including testes), the ovaries of the female neonates were clearly affected by HTO. Illustrative slides from animals of Groups 1, 5, and 7 are shown in Figures 3, 4, and 5, respectively. In the control animal (Figure 3), many large oocytes are visible, each surrounded by inconspicuous follicular cells, the latter encompassed by scant connective tissue. External to the capsule is a single row of cuboidal cells comprising the germinal epithelium. In the neonates from the HTO groups, particularly at the highest dose level (Figure 5), markedly fewer oocytes and many more follicular cells are apparent.

Even on this subjective basis, the squirrel monkey oocyte population appears to be remarkably sensitive to HTO exposure during gestation on the basis of the body water concentration of HTO. For the mouse, exposure to about 3.0 μCi/ml (body water) from conception through 14 days of age results in an oocyte survival of about 34%. In the present study, animals of Group 7 had a mean body water HTO level of about 3 μCi/ml, and the oocyte survival in that group clearly was much less than 30%. The apparent dose-response relationship observed in this study is being



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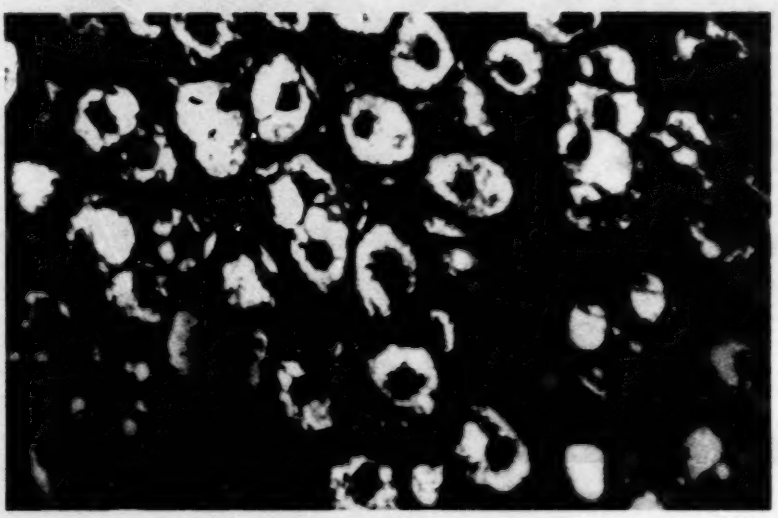

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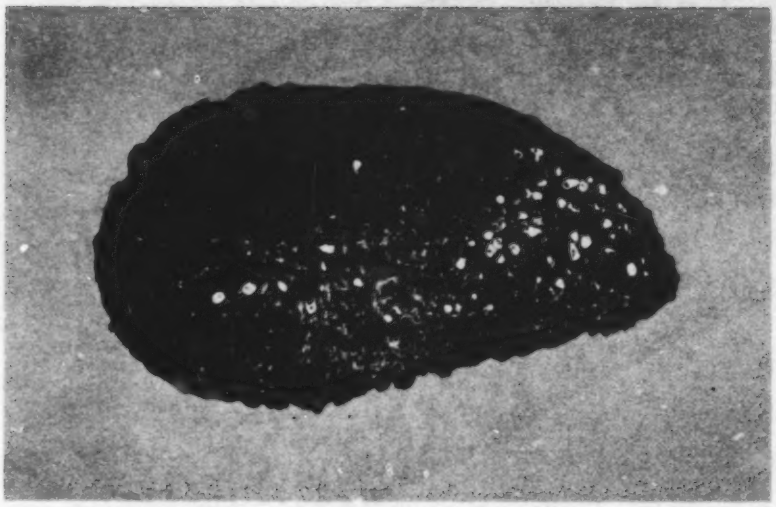
FIGURE 3 LOW- AND HIGH-MAGNIFICATION PHOTOMICROGRAPHS OF A GROUP 1 NEONATE OVARY



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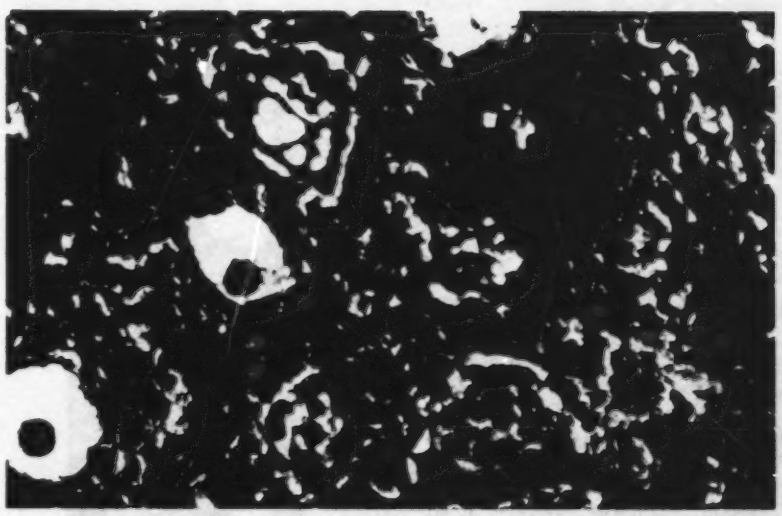

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FIGURE 4 LOW- AND HIGH-MAGNIFICATION PHOTOMICROGRAPHS OF A GROUP 5 NEONATE OVARY

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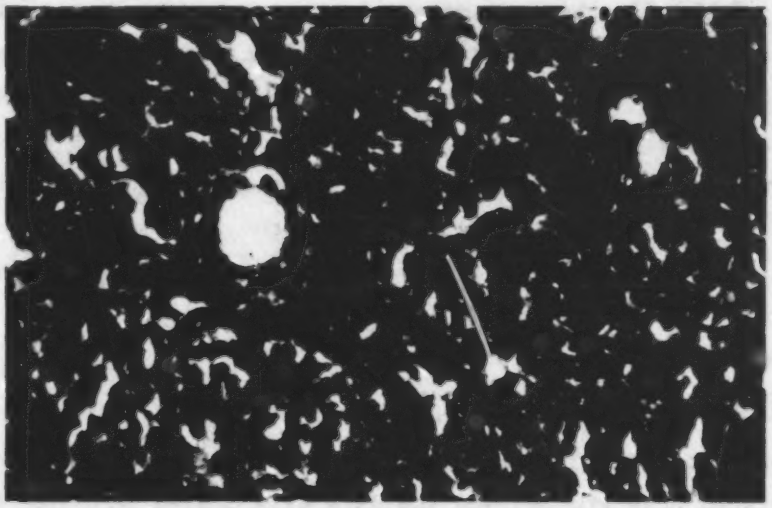

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FIGURE 5 LOW- AND HIGH-MAGNIFICATION PHOTOMICROGRAPHS OF A GROUP 7 NEONATE OVARY

quantified by Dr. Dobson, who is evaluating the neonate ovaries from this project using a quantitative procedure.[8,9] When these data become available, the relative sensitivity of the squirrel monkey as compared with other species can be assessed more meaningfully. Also, additional quantitative evaluations of the retinas from all of the neonates and of the brains from some will be attempted under similar collaborative arrangements.

Finally, several adult female squirrel monkeys (from Groups 1 and 4 through 7) have been unilaterally ovariectomized, and the ovaries have been fixed in a more appropriate fixative (Bouin's) for future quantitative evaluation. This effort is being undertaken to provide information on the ovaries of the HTO-exposed adults comparable to that for the neonates, because studies in rodents have indicated that the oocyte count can be reduced even with postnatal irradiation.[8]

Table 22 summarizes selected body dimensions, body weight, and the weights of selected organs by dose group. No relationship between dose of HTO and any of the 13 other parameters is apparent. However, a difference in dimensions and weight between male and female full-term progeny was apparent. The same data tabulated according to sex are shown in Tables 23 and 24. Analysis of variance indicated a significant ($p < 0.025$) difference between the body weights of female progeny and those of male progeny. Although not evaluated statistically, the values for each of the other 12 parameters were greater for males than for females, consistent with the body weight relationship.

Hematology and Serology

Inspection of the individual hematologic data revealed no apparent differences between dose groups, and the data were pooled for statistical description shown in Table 25. Values for RBC, Hgb, Hct, MCV, MCH, and MCHC in the present study are in extremely close agreement with those recently reported for neonate squirrel monkeys of Colombian origin.[10] The latter report gives appreciably higher mean values than those shown in Table 25 for WBC (11.07 vs 6.75) and for the percentage of neutrophils

(77 vs 66.8), but the variability for these parameters appears relatively large for both sets of data. The present data confirm the findings of Ausman et al.,[10] for the neonate squirrel monkey:[11-13] elevated Hgb, Hct, and RBC count, and macrocytes (MCV).

In only five cases was sufficient blood available for serology. Table 26 shows these data. No conclusions about dose response are possible. Compared with adult squirrel monkeys,[10-12] neonates had somewhat higher values for calcium and cholesterol and markedly lower globulin and carbon dioxide values. Corresponding adult values for creatinine, triglycerides, and iron are not available, and apparent differences in the alkaline phosphatase and SGPT methods prevent comparison for those parameters. Present values for protein appear comparable to the mean neonate value of 5.46 g% reported by Ausman et al.,[10] but the present values for albumin appear somewhat higher than the mean of 3.08 g% they reported.

Table 1. SCHEDULED HTO VALUES

Group Number	Desired Body HTO (μCi/ml)	Initial Injection (mCi)	Drinking Water HTO (μCi/ml)	
			Initial	Final
1	0	0	0	0
2	0.05	0.023	0.060	0.072
3	0.2	0.091	0.240	0.290
4	0.5	0.23	0.600	0.720
5	1.0	0.46	1.200	1.450
6	2.0	0.91	2.410	2.900
7	4.0	1.82	4.820	5.800

Table 2. MEAN ASSAYED HTO DRINKING WATER ACTIVITY
(Microcuries per Milliliter)

	Date	Group					
		2	3	4	5	6	7
	6/7/76	0.048	0.186	0.483	0.938	1.856	4.013
	6/11	0.045	0.196	0.472	0.938	1.932	3.607
	6/18	0.047	0.181	0.469	0.915	1.847	3.581
	6/25	0.040	0.149	0.370	0.824	1.637	3.225
N		4	4	4	4	4	4
Mean		0.045	0.178	0.448	0.904	1.818	3.606
S.D.		0.004	0.020	0.053	0.054	0.127	0.322
	7/2	0.064	0.247	0.598	1.189	2.347	4.763
	7/9	--	--	--	--	2.333	4.545
N		1	1	1	1	2	2
Mean		0.064	0.247	0.598	1.189	2.340	4.654
S.D.		--	--	--	--	0.010	0.154
	7/16	--	--	--	--	--	--
	7/23	0.071	0.321	0.637	--	2.874	5.742
	7/30	0.081	0.357	0.667	1.463	2.894	5.714
	8/6	0.077	0.320	0.704	1.378	2.873	5.787
	8/13	--	--	--	--	3.431	5.749
	8/20	--	--	0.838	--	--	--
	8/27	0.071	0.316	--	--	--	--
	9/3	--	--	--	--	--	--
	9/10	0.094	0.299	0.682	1.462	3.016	5.930
	9/17	0.065	0.258	0.716	1.282	2.723	5.431
	9/24	0.081	0.303	0.714	1.397	2.906	5.849
	10/1	0.056	0.211	0.572	1.190	2.584	5.760
	10/8	--	0.306	0.732	1.386	2.896	5.723
	10/15	0.097	0.300	0.700	1.417	2.816	5.730
	10/22	0.094	0.299	0.768	1.414	2.822	5.974
	10/29	0.078	0.288	0.740	1.380	2.766	5.690
	11/5	0.077	0.286	0.714	1.427	2.952	5.862
	11/12	0.070	0.265	0.660	1.324	2.600	5.663
	11/19	0.074	0.275	0.740	1.386	2.838	6.332
	11/26	0.068	0.262	0.820	1.346	2.876	5.738
	12/3	0.077	0.266	0.719	1.440	3.004	5.881
	12/10	0.082	0.280	0.761	1.517	3.130	6.210
	12/17	0.072	0.262	0.712	1.413	2.935	5.940
	12/24	0.076	0.283	0.767	1.494	3.131	6.312
	12/31	0.068	0.264	0.722	1.467	3.006	5.960
	1/7/77	0.075	0.279	0.766	1.539	3.171	6.130
	1/14	0.072	0.263				
N		22	23	22	20	22	22
Mean		0.076	0.285	0.720	1.406	2.920	5.868
S.D.		0.010	0.030	0.058	0.081	0.189	0.220

Table 3. PREGNANCY EVALUATION DATA FOR INSEMINATED FEMALE SQUIRREL MONKEYS RECEIVING HTO IN DRINKING WATER

Group	No. Insemi-nated	No. Evalu-ated	No. Positive	No. of Full-Term Deliveries	No. of Frank Abortions	No. of Resorp-tions	Percent Resorp-tion	Percent Pregnant
1	43	37	15	6	1	8	53	40
2	38	35	18	7	0	11	61	51
3	38	33	12	3	3	6	50	36
4	41	36	19	4	1	14	74	53
5	38	36	20	7	3	10	50	56
6	39	36	22	9	0	13	59	61
7	41	33	15	7	0	8	53	46
Total	277	246	121	43*	8*	70	58	49

*Three full-term deliveries and two frank abortions occurred in animals not evaluated for pregnancy.

Table 4. BODY WEIGHTS OF INSEMINATED FEMALE SQUIRREL MONKEYS NOT PROVIDING FULL-TERM DELIVERIES OR EVIDENCE OF FRANK ABORTION (Grams)

Group	Item	Weeks Postinsemination					
		1 to 4	5 to 8	9 to 12	13 to 16	17 to 20	21 to 24
1	N	13	49	45	31	37	33
	Mean	635	722	754	757	771	787
	S.D.	26	66	73	86	78	72
2	N	6	44	39	28	29	24
	Mean	657	695	711	720	728	724
	S.D.	60	48	55	57	61	60
3	N	7	46	40	30	29	24
	Mean	703	715	723	735	729	764
	S.D.	55	56	59	73	66	82
4	N	10	58	36	31	29	23
	Mean	659	704	708	733	735	752
	S.D.	41	55	51	59	64	77
5	N	12	48	31	22	28	21
	Mean	699	718	730	747	736	741
	S.D.	60	63	63	72	64	75
6	N	13	54	34	26	26	25
	Mean	635	702	725	743	739	750
	S.D.	32	41	49	63	67	60
7	N	13	58	33	28	27	27
	Mean	672	692	708	722	713	723
	S.D.	59	43	55	47	46	54

Table 5. BODY WEIGHTS OF FEMALE SQUIRREL MONKEYS DELIVERING FULL-TERM PROGENY (Grams)

Group	Item	Weeks of Pregnancy					
		1 to 4	5 to 8	9 to 12	13 to 16	17 to 20	21 to 22
1	N	2	7	8	6	6	2
	Mean	704	754	787	879	914	867
	S.D.	11	66	79	102	125	2
2	N	2	12	9	8	8	3
	Mean	583	709	735	789	857	862
	S.D.	45	39	40	60	64	32
3	N	--	9	3	4	4	2
	Mean	--	718	727	787	822	868
	S.D.	--	39	64	85	86	68
4	N	--	6	6	4	4	2
	Mean	--	716	737	798	844	789
	S.D.	--	30	38	91	107	44
5	N	--	11	10	7	7	4
	Mean	--	754	765	848	893	896
	S.D.	--	72	65	83	89	90
6	N	--	17	11	10	9	5
	Mean	--	736	773	838	903	916
	S.D.	--	62	59	84	80	103
7	N	1	14	12	8	8	1
	Mean	622	759	792	853	919	879
	S.D.	--	51	56	76	80	--

Table 6. TIME DISTRIBUTION OF FULL-TERM BIRTHS
M = Male; F = Female

Days Post-insemination	Group							All
	1	2	3	4	5	6	7	
87		F*						1*
136	F							1
141						M		1
144					F†M			2
145	M†					M		2
148							F	1
149		M						1
151					FF	MMF	F	6
152	F	MF		M		F		5
153	F		F			M	FFFF	7
154	M	F†F	MM		M	M		7
155		M		M				2
156	M	F	F†	MM		F		6
157					F			1
158							FF	2
159					M			1
Total	6	8	4	4	7	9	8	46
Median	152.5	154.0	154.0	155.6	151.0	151.0	153.0	153.0
Mean	149.3	153.1	154.2	154.8	151.4	150.4	153.4	152.1

*Excluded from mean.

†Stillborn.

Table 7. ESTIMATES OF GESTATION PERIOD FOR THE SQUIRREL MONKEY

Days of Breeding	No. of Animals	Individual Days Postinsemination to Birth						
1	7	141	151	152	153	153	154	158
2	5	151	153	153	154	154		
3	1	151						
4	2	152	158					
5	4	152	152	155	156			
6	4	149	151	151	153			
7	3	153	154	156				
8	6	144	144	153	154	154	155	
9	3	154	156	157				
10	2	145	152					
11	1	156						
13	1	159						
14	1	148						
15	1	145						
26	1	156						
2(1)1	1	156						
2(13)1(4)1	1	151						
2(6)7	1	136						
37(32)1	1	87						

Table 8. MEAN HTO CONCENTRATIONS IN URINE OF INSEMINATED ADULT FEMALE SQUIRREL MONKEYS
(Microcuries per Milliliter)
N = Number of Samples

Week Ending	Group 2			Group 3			Group 4			Group 5			Group 6			Group 7		
	N	Mean	S.D.	N	Mean	S.D.	N	Mean	S.D.	N	Mean	S.D.	N	Mean	S.D.	N	Mean	S.D.
6/4/76	2	0.032	0.002	2	0.138	0.018	3	0.316	0.046	4	0.695	0.122	3	1.175	0.202	2	2.641	0.086
6/11	7	0.015	0.006	9	0.093	0.033	7	0.185	0.054	7	0.565	0.197	7	1.268	0.303	5	2.344	0.234
6/18	18	0.025	0.006	17	0.099	0.024	14	0.252	0.037	14	0.556	0.059	15	1.128	0.234	16	2.427	0.182
6/25	13	0.026	0.006	11	0.093	0.011	19	0.227	0.100	14	0.523	0.081	13	0.971	0.208	16	2.032	0.386
7/2	24	0.024	0.005	26	0.112	0.034	21	0.290	0.042	27	0.512	0.130	25	1.132	0.329	22	2.427	0.557
7/9	30	0.032	0.011	29	0.121	0.048	27	0.298	0.068	26	0.520	0.112	28	1.175	0.432	28	2.290	0.845
7/16	28	0.047	0.015	23	0.151	0.045	*	--	--	*	--	--	31	1.534	0.340	20	3.267	1.095
7/23	27	0.050	0.007	22	0.193	0.038	23	0.357	0.086	25	0.897	0.186	32	1.832	0.277	25	3.124	0.810
7/30	24	0.049	0.009	29	0.199	0.041	27	0.382	0.075	27	0.850	0.165	27	1.832	0.419	22	2.987	0.835
8/6	30	0.054	0.013	28	0.181	0.044	28	0.444	0.080	34	0.833	0.131	20	1.954	0.291	18	2.945	0.634
8/13													31	1.884	0.486	33	3.318	0.819
8/20																		
8/27	22	0.042	0.005	19	0.161	0.037	32	0.293	0.134	35	0.690	0.276						
9/10																		
9/17																		
9/24	27	0.045	0.009	26	0.165	0.038	32	0.361	0.103	33	0.631	0.179	34	1.326	0.431	33	2.707	0.726
10/8																		
10/15																		
10/22	18	0.063	0.011	27	0.164	0.039	34	0.335	0.091	31	0.801	0.193	33	1.446	0.289	32	2.785	0.725
11/5																		
11/12																		
11/19	25	0.030	0.010	15	0.127	0.022	24	0.384	0.156	19	0.471†	0.143	28	1.315	0.299	34	2.877	0.602
12/3																		
12/10																		
12/17	22	0.035	0.006	20	0.130	0.023	22	0.330	0.067	17	0.667	0.211	23	1.485	0.385	20	3.486	0.900
12/31																		
1/7/77													8	1.346	0.419	7	3.232	0.863
1/14	2	0.027	0.005	3	0.064	0.056	6	0.288	0.082	7	0.722	0.113						

*Samples lost by accident.

†Possible contamination with rain water.

Table 9. CONCENTRATIONS OF HTO
IN URINE OF CONTROL ANIMALS
NOT RECEIVING HTO IN DRINKING WATER
(Microcuries per Milliliter)

Week Ending	No. of Animals Tested	Mean	S.D.
6/4/76	3	0	--
6/11	8	0	--
6/18	14	0	--
6/25	19	0.00116	0.00112
7/2	26	0.00019	0.00049
7/9	29	0.00052	0.00078
7/16	25	0.00108	0.00064
7/23/76	29	0.00483	0.00275
7/30/76	28	0.00764	0.00296
8/6	34	0.00324	0.00148
9/3	23	0.00461	0.00244
10/1	31	0.00416	0.00267
10/29	14	0.00464	0.00139
11/26	23	0.00335	0.00147
12/24	5	0.00180	0.00045
1/12/77	5	0.00140	0.00089

Table 10. URINARY CONCENTRATION OF HTO
IN GROUP 1 ADULT SQUIRREL MONKEYS DELIVERING FULL-TERM PROGENY
(Microcuries per Milliliter)

Date (1976)	Animal Number					
	542	546	641	800	813	852
6/4		0.001				
6/18	< 0.001	< 0.001	< 0.001			
6/25	< 0.001	0.001	0.001	--		
7/2	--	< 0.001	< 0.001	--	< 0.001	
7/9	0.001	0.001	0.001	--	< 0.001	
7/16	0.001	< 0.001	< 0.001	--	0.002	0.001
7/23	0.003	0.003	0.003	--	0.006	0.013
7/30	0.008	0.005	0.009	--	0.010	0.004
8/6	0.003	0.002	0.001	0.006	0.005	0.004
9/3	0.002	--	0.003	--	0.008	0.008
10/1	0.002	0.002	0.002	0.005	0.006	0.006
10/29	0.003	0.006	0.002	0.007	0.005	0.005
11/26					0.004	0.002
Days	136	145	156	153	152	154
Mean*	0.0024	0.0020	0.0026	0.0044	0.0056	0.0050
S.D.	0.0005	0.0004	0.0006	0.0010	0.0012	0.0011

*Weighted according to the number of days of pregnancy during the periods 5/29 - 6/25, 6/26 - 7/9, and 7/10 - delivery. Dash indicates no satisfactory sample was obtained; blank indicates animal was not yet inseminated or was postpartum.

Table 11. URINARY CONCENTRATION OF HTO
IN GROUP 2 ADULT SQUIRREL MONKEYS DELIVERING FULL-TERM PROGENY
(Microcuries per Milliliter)

Date (1976)	Animal Number							
	503	545	656	685	692	717	737	819
6/4			--					
6/11		0.022	0.014					
6/18		0.025	0.027	0.027	0.033			
6/25		0.035	0.025	--	0.029	--	--	
7/2		0.027	0.021	0.017	0.027	0.032	0.029	
7/9		0.027	0.038	0.044	0.049	0.040	0.035	0.022
7/16		0.036	0.049	0.057	0.055	0.054	0.038	--
7/23		0.046	0.045	0.059	0.060	0.063	0.052	--
7/30	--	0.050	0.041	0.064	0.040	0.063	0.056	0.047
8/6	0.049	--	0.046	0.068	0.066	0.067	0.069	0.052
8/27	0.045	0.044	0.031	0.045	0.043	0.041	--	0.042
9/24	0.043	0.077	0.038	0.051	0.053	0.064	0.031	0.039
10/22	--	0.077	0.059	0.066	0.056	--	--	0.047
11/19						0.043	0.049	0.047
Days	87	152	155	152	149	154	154	156
Mean*	0.046	0.049	0.038	0.054	0.050	0.053	0.047	0.045
S.D.	0.010	0.011	0.008	0.012	0.011	0.012	0.010	0.010

*Weighted according to the number of days of pregnancy during the periods 5/29 - 6/25, 6/26 - 7/9, and 7/10 - delivery. Dash indicates no satisfactory sample was obtained; blank indicates animal was not yet inseminated or was postpartum.

Table 12. URINARY CONCENTRATION OF HTO IN GROUP 3 ADULT SQUIRREL MONKEYS DELIVERING FULL-TERM PROGENY (Microcuries per Milliliter)

Date (1976)	Animal Number			
	719	747	764	805
6/11	--			
6/18	0.085			
6/25	0.087	--	--	--
7/2	0.103	0.118	0.098	0.097
7/9	0.098	0.123	0.038	0.146
7/16	--	0.124	--	0.052
7/23	0.298	0.163	--	--
7/30	0.169	0.222	--	0.169
8/6	0.111	0.102	--	0.181
8/27	0.135	--	0.187	0.187
9/24	0.123	0.167	0.191	0.179
10/22	0.197	0.184	0.174	0.207
11/19		0.083	--	0.164
Days	154	154	156	153
Mean*	0.157	0.145	0.171	0.156
S.D.	0.035	0.032	0.038	0.034

*Weighted according to the number of days of pregnancy during the periods 5/29 - 6/25, 6/26 - 7/9, and 7/10 - delivery. Dash indicates no satisfactory sample was obtained; blank indicates animal was not yet inseminated or was postpartum.

Table 13. URINARY CONCENTRATION OF HTO IN GROUP 4 ADULT SQUIRREL MONKEYS DELIVERING FULL-TERM PROGENY (Microcuries per Milliliter)

Date (1976)	Animal Number			
	640	686	688	702
6/4		0.366	--	
6/11		0.158	0.087	
6/18	--	0.243	0.177	0.250
6/25	0.280	0.314	0.033	0.042
7/2	0.274	0.273	--	--
7/9	0.306	--	--	0.215
7/23	--	0.324	0.285	0.353
7/30	0.281	0.279	0.252	0.381
8/6	0.386	0.332	0.367	0.454
8/20	0.149	0.403	0.306	0.435
9/17	--	0.415	0.282	0.537
10/15	0.415	0.411	0.243	0.328
11/12	0.522			0.526
Days	156	156	155	152
Mean	0.341	0.338	0.251	0.387
S.D.	0.075	0.074	0.055	0.085

*Weighted according to the number of days of pregnancy during the periods 5/29 - 6/25, 6/26 - 7/9, and 7/10 - delivery. Dash indicates no satisfactory sample was obtained; blank indicates animal was not yet inseminated or was postpartum.

Table 14. URINARY CONCENTRATION OF HTO
IN GROUP 5 ADULT SQUIRREL MONKEYS DELIVERING FULL-TERM PROGENY
(Microcuries per Milliliter)

Date (1976)	Animal Number						
	500	575	693	696	732	740	761
6/4	0.871		0.656				
6/11	0.907	--	0.611				
6/18	--	0.497	0.637	--			--
6/25	0.591	0.363	0.653	0.477	--	--	--
7/2	0.173	0.505	0.558	0.418	0.675	0.487	--
7/9	0.443	0.556	0.682	0.583	0.336	--	--
7/23	0.764	0.826	0.675	1.461	0.939	0.921	0.777
7/30	1.088	0.986	1.083	0.737	0.911	0.911	0.563
8/6	0.880	0.896	1.010	0.643	0.462	0.732	0.905
8/20	0.131	0.839	0.754	0.687	0.649	0.966	1.451
9/17	0.920	0.812	0.811	0.734	0.694	0.874	0.758
10/15	0.958	0.776	0.854	0.790	0.834	0.980	1.239
11/12				--	0.506	0.621	0.236
Days	159	154	157	151	144	144	151
Mean*	0.748	0.766	0.803	0.784	0.690	0.667	0.795
S.D.	0.164	0.168	0.177	0.172	0.152	0.147	0.175

*Weighted according to the number of days of pregnancy during the periods 5/29 - 6/25, 6/26 - 7/9, and 7/10 - delivery. Dash indicates no satisfactory sample was obtained; blank indicates animal was not yet inseminated or was postpartum.

Table 15. URINARY CONCENTRATION OF HTO
IN GROUP 6 ADULT SQUIRREL MONKEYS DELIVERING FULL-TERM PROGENY
(Microcuries per Milliliter)

Date (1976)	Animal Number								
	515	549	556	561	628	689	711	718	791
6/4	--	0.942							
6/11	1.165	0.833		--	--				
6/18	0.978	0.965	0.961	1.128	1.063	--			
6/25	--	0.968	0.910	1.036	0.664	1.015	--	--	--
7/2	0.976	0.985	1.300	0.998	1.333	0.300	1.492	1.353	--
7/9	--	0.954	1.943	1.840	1.174	0.756	1.244	0.885	0.496
7/16	1.444	1.357	1.763	1.671	1.540	1.344	1.567	1.055	2.168
7/23	--	1.761	2.273	2.583	1.668	1.751	2.035	1.445	1.824
7/30	--	1.767	2.164	--	1.795	1.647	2.132	--	1.454
8/6	--	1.844	2.204	2.163	1.676	2.041	2.235	2.076	--
8/13	1.587	2.101	2.200	2.150	1.388	1.554	1.551	1.598	2.071
9/10	1.697	1.811	1.641	1.622	1.377	1.424	1.505	1.832	1.960
10/8	1.077	2.007	1.530	1.900	1.611	1.537	1.666	1.858	1.912
11/5			1.831	1.989	1.456	--	1.490	1.734	1.407
Days	151	151	152	154	151	153	156	145	141
Mean*	1.352	1.566	1.827	1.855	1.452	1.472	1.717	1.618	1.578
S.D.	0.297	0.345	0.402	0.408	0.319	0.324	0.378	0.356	0.347

*Weighted according to the number of days of pregnancy during the periods 5/29 - 6/25, 6/26 - 7/9, and 7/10 - delivery. Dash indicates no satisfactory sample was obtained; blank indicates animal was not yet inseminated or was postpartum.

Table 16. URINARY CONCENTRATION OF HTO
IN GROUP 7 ADULT SQUIRREL MONKEYS DELIVERING FULL-TERM PROGENY
(Microcuries per Milliliter)

Date (1976)	Animal Number							
	508	585	606	661	722	763	798	884
6/4	--	--		2.580				
6/11	2.269	2.500	--	1.975				
6/18	2.728	2.380	2.607	2.313	2.654			
6/25	2.561	--	1.481	1.302	1.903	--	--	
7/2	2.323	2.883	2.102	--	2.448	1.755	--	
7/9	2.383	2.582	2.368	2.323	2.324	1.445	1.474	
7/16	3.810	3.440	--	3.499	--	--	4.831	
7/23	3.025	3.823	2.593	3.129	5.011	--	3.316	
7/30	--	4.961	3.213	2.904	2.644	1.881	2.565	
8/6	2.789	3.322	2.331	2.859	2.545	--	2.152	--
8/13	2.332	2.699	2.898	4.044	2.740	3.651	2.975	4.019
9/10	3.236	3.581	3.586	2.826	3.072	3.570	3.612	2.237
10/8	3.965	3.976	3.518	3.417	2.388	3.282	1.782	2.794
11/5	--	3.860	3.690	3.444	2.951	3.527	3.581	3.162
12/3								3.792
12/31								4.343
Days	148	153	153	153	158	158	153	151
Mean*	3.004	3.428	2.925	2.971	2.928	2.990	3.055	3.391
S.D.	0.661	0.754	0.644	0.654	0.644	0.658	0.672	0.746

*Weighted according to the number of days of pregnancy during the periods 5/29 - 6/25, 6/26 - 7/9, and 7/10 - delivery. Dash indicates no satisfactory sample was obtained; blank indicates animal was not yet inseminated or was postpartum.

Table 17. ANALYSIS OF MEAN* HTO CONCENTRATION IN URINE OF PREGNANT AND NONPREGNANT FEMALE SQUIRREL MONKEYS

	Group					
	2	3	4	5	6	7
Nonpregnant						
Mean HTO (μCi/ml)	0.0391	0.149	0.349	0.666	1.470	2.776
Number of samples	245	251	250	215	257	240
Pregnant						
Mean HTO (μCi/ml)	0.0447	0.154	0.313	0.718	1.537	3.018
Number of samples	69	52	51	92	92	86
Difference						
μCi/ml	+0.0056	+0.005	-0.036	+0.052	+0.067	+0.242
Percent	+14.6	+3.4	-10.3	+7.8	+4.6	+8.7
Pooled S.D.	0.0148	0.0496	0.106	0.219	0.447	0.785
t for difference	2.74	0.63	3.23	1.91	1.23	2.44

*Unweighted, microcuries per milliliter.

Table 18. TISSUE RADIOACTIVITY OF NEONATE SQUIRREL MONKEYS
(Microcuries per Gram of Wet Tissue)

	Animal Number	Brain	Liver	Kid	Adr	Spl	GIT	Plac	Skin	Blood	Mus	Heart
	1.542*	0.007	0.006	0.016	0.007	0.011	0.008		0.003		0.009	0.006
	1.546	0.011	0.010	0.010	0.011			0.012	0.008			0.014
	1.641		0.003	0.006	0.005	0.012	0.003		0.001	0.002	0.006	0.003
	1.800		0.002	0.003	0.006	0.001	0.002		0.001	0.001	0.003	0.005
	1.813		0.003	0.003	0.006	0.007	0.004	0.004	0.001	0.001	0.005	0.008
	1.852	0.001	0.001	0.001	0.001	0.001	0.001		0.001	0.001	0.001	0.001
N		3	6	6	6	5	5	2	6	4	5	6
Mean		0.006	0.004	0.006	0.006	0.006	0.003	0.008	0.002	0.001	0.004	0.006
S.D.		0.005	0.003	0.005	0.003	0.005	0.002	0.005	0.002	0.000	0.003	0.004
	2.503	0.054	0.051	0.042	0.045	0.030	0.051	0.029	0.035			0.029
	2.544	0.047	0.044	0.048	0.033	0.040	0.028	0.044	0.049	0.044	0.046	0.044
	2.656	0.063	0.049	0.046	0.038	0.036	0.038		0.047	0.041	0.040	0.038
	2.685		0.042	0.036	0.034	0.019	0.025		0.041	0.046	0.044	0.032
	2.692	0.041	0.045	0.044	0.036	0.029	0.033	0.028	0.040	0.043	0.036	0.039
	2.717		0.041	0.029	0.040	0.042	0.032		0.045	0.024	0.036	0.040
	2.737		0.038	0.040	0.039	0.046	0.035	0.042	0.046	0.021	0.039	0.038
	2.819		0.036	0.032	0.027	0.033	0.026		0.034		0.027	0.039
N		4	8	8	8	8	8	4	8	6	7	8
Mean		0.051	0.043	0.039	0.036	0.034	0.033	0.035	0.042	0.036	0.038	0.037
S.D.		0.009	0.005	0.006	0.005	0.008	0.008	0.008	0.005	0.011	0.006	0.004
	3.719	0.142	0.133	0.136	0.140	0.130	0.076	0.106	0.163	0.099	0.140	0.124
	3.747	0.170	0.157	0.114	0.115	0.096	0.101		0.316	0.078	0.124	0.086
	3.764		0.144	0.153	0.133	0.121	0.116		0.186	0.125	0.143	0.121
	3.805		0.127	0.135	0.118	0.117	0.123	0.143	0.136		0.105	0.123
N		2	4	4	4	4	4	2	4	3	4	4
Mean		0.156	0.140	0.134	0.126	0.116	0.104	0.124	0.200	0.100	0.128	0.114
S.D.		0.020	0.013	0.016	0.012	0.014	0.020	0.026	0.079	0.023	0.017	0.018
	4.640	0.507	0.537	0.395	0.373	0.374	0.294	0.344	0.350		0.414	0.353
	4.686	0.624	0.469	0.504	0.483	0.426				0.397	0.422	0.429
	4.688	0.497	0.404	0.399	0.390	0.371	0.440		0.267	0.265	0.363	0.405
	4.702		0.369	0.402	0.231	0.222	0.270		0.469	0.390	0.455	0.292
N		3	4	4	4	4	3	1	3	3	4	4
Mean		0.542	0.445	0.425	0.369	0.348	0.335	0.344	0.362	0.350	0.414	0.370
S.D.		0.070	0.074	0.053	0.104	0.087	0.092		0.102	0.074	0.038	0.061
	5.500	0.765	0.771	0.674	0.536	0.403	0.559		0.942	0.696	0.819	0.524
	5.575	0.954	0.746	0.819	0.554	0.535	0.571	0.960	0.815	0.588	0.826	0.721
	5.693	1.096	0.875	0.925	0.911	1.045	0.908	0.811	0.790	0.788	0.715	0.751
	5.696		0.983	0.815	0.746	0.662	0.606	0.710	0.845	0.603	0.842	0.788
	5.732		0.603	0.507	0.442	0.838	0.166		0.619	0.410		0.353
	5.740		0.701	0.736	0.623	0.606	0.727	0.627	0.762		0.671	0.620
	5.761		0.634	0.616	0.612	0.543	0.547	0.507	0.797	0.645	0.686	0.628
N		3	7	7	7	7	7	5	7	6	6	7
Mean		0.938	0.759	0.726	0.632	0.661	0.583	0.722	0.795	0.621	0.760	0.626
S.D.		0.166	0.133	0.140	0.153	0.215	0.224	0.172	0.097	0.126	0.076	0.150
	6.315	1.647	1.273	1.518	1.118				0.973	1.202	1.428	1.257
	6.439	1.903	1.412	1.261	0.941	0.947	0.848	1.478	1.172		1.329	1.254
	6.556	1.692	1.584	1.045	0.695	0.396	0.501		1.800	1.245	0.520	0.180
	6.561	1.747	1.710	1.945	1.383	1.209	1.213		1.909	1.347	1.695	1.427
	6.628	1.356	0.973	0.707	0.643		0.519	0.632	1.144	0.986	0.382	0.499
	6.689		1.377	1.512	0.997	1.142	1.043		1.260	1.324	0.858	1.137
	6.711		1.482	1.337	0.969	0.822	1.111		1.555	1.195	1.252	1.076
	6.718		1.406	1.411	1.104	1.108	0.999		1.300	1.450	1.572	1.366
	6.791	1.439	1.531	1.509	1.432	0.622	1.413		1.482	1.267	1.490	1.483
N		6	9	9	9	7	8	2	9	8	9	9
Mean		1.675	1.416	1.360	1.031	0.892	0.955	1.055	1.399	1.252	1.169	1.075
S.D.		0.244	0.209	0.344	0.267	0.299	0.320	0.598	0.312	0.136	0.471	0.443
	7.508	3.718	3.310	4.165	3.796	3.140			5.045	3.581		4.041
	7.585	3.713	3.379	3.563	2.676	2.196	2.289		3.258	3.467	3.495	2.456
	7.606	2.870	1.331	1.092	0.744	0.866	0.560		2.920		0.828	1.133
	7.661	2.511	2.487	2.521	1.848	1.518	1.983			2.945	2.510	2.262
	7.722		2.584	1.695	0.805	0.490	0.803	1.413	3.264	2.832	1.453	0.583
	7.763		3.373	3.427	2.132	3.076	2.747		3.198	2.598	2.365	2.876
	7.798		3.051	3.133	1.565	2.375	2.542		2.908	2.094	2.900	2.513
	7.884		3.339	3.153	3.127	1.634	2.097		2.308	3.362	1.502	2.890
N		4	8	8	8	8	7	1	7	7	7	8
Mean		3.202	2.856	2.843	2.086	1.911	1.860	1.413	3.272	2.982	2.150	2.344
S.D.		0.609	0.712	1.019	1.077	0.964	0.847		0.849	0.532	0.930	1.074

*In this computerized format (also used in subsequent tables), the integer is the group number and the remainder is the animal number.

Table 19. TISSUE RADIOACTIVITY OF NEONATE SQUIRREL MONKEYS AFTER DEHYDRATION
(Microcuries per Gram of Wet Tissue)

	Animal Number	Brain	Liver	Kid	Adr	Spl	GIT	Plac	Skin	Blood	Mus	Heart
	1.542	0.001	0.001	0.001	0.001	0.001	0.001		0.001		0.001	0.001
	1.546	0.001	0.001	0.001	0.001			0.001	0.001			0.001
	1.641		0.001	0.001	0.001	0.001	0.001		0.001	0.001	0.001	0.001
	1.800		0.001	0.001	0.001	0.001	0.001		0.001	0.001	0.001	0.001
	1.813		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	1.852	0.001	0.001	0.001	0.001	0.001	0.001		0.001	0.001	0.001	0.001
N		3	6	6	6	5	5	2	6	4	5	6
Mean		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	2.503	0.001	0.001	0.001	0.001	0.001	0.004	0.001	0.002			0.001
	2.545	0.003	0.003	0.004	0.010	0.016	0.007	0.003	0.002	0.001	0.007	0.005
	2.656	0.004	0.007	0.007	0.014	0.015	0.008		0.005	0.001	0.005	0.002
	2.685		0.001	0.001	0.001	0.001	0.001		0.001	0.001	0.001	0.001
	2.692	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	2.717		0.001	0.001	0.001	0.001	0.001		0.001	0.001	0.001	0.001
	2.737		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	2.819		0.001	0.001	0.001	0.001	0.001		0.001		0.001	0.001
N		4	8	8	8	8	8	4	8	6	7	8
Mean		0.002	0.002	0.002	0.003	0.004	0.003	0.001	0.001	0.001	0.002	0.001
S.D.		0.001	0.002	0.002	0.005	0.006	0.002	0.001	0.001		0.002	0.001
	3.719	0.003	0.001	0.001	0.001	0.001	0.001	0.001	0.006	0.001	0.003	0.001
	3.747	0.006	0.003	0.003	0.006	0.005	0.003		0.010	0.001	0.003	0.004
	3.764		0.003	0.002	0.001	0.001	0.001		0.007	0.001	0.002	0.001
	3.805		0.002	0.002	0.003	0.003	0.003	0.002	0.004		0.002	0.002
N		2	4	4	4	4	4	2	4	3	4	4
Mean		0.004	0.002	0.002	0.003	0.002	0.002	0.001	0.006	0.001	0.002	0.002
S.D.		0.002	0.001	0.001	0.002	0.001	0.001	0.000	0.002		0.001	0.001
	4.640	0.009	0.001	0.003	0.003	0.005	0.004	0.001	0.016		0.004	0.003
	4.686	0.011	0.005		0.008	0.001				0.001	0.003	0.003
	4.688	0.011	0.004	0.003	0.005	0.002	0.004		0.004	0.001	0.003	0.004
	4.702		0.008	0.007	0.020	0.011	0.008		0.019	0.001	0.011	0.007
N		3	4	3	4	4	3	1	3	3	4	4
Mean		0.010	0.004	0.004	0.009	0.004	0.005	0.001	0.013	0.001	0.005	0.004
S.D.		0.001	0.003	0.002	0.008	0.004	0.002		0.008		0.004	0.002
	5.500	0.026	0.012	0.006	0.024	0.004	0.012		0.023	0.002	0.016	0.007
	5.575	0.030	0.016	0.014	0.061	0.020	0.018	0.049	0.021	0.002	0.016	0.012
	5.693	0.030	0.011	0.009	0.022	0.009	0.008	0.005	0.012	0.002	0.013	0.008
	5.696		0.013	0.007	0.014	0.010	0.006	0.002	0.032	0.002	0.010	0.005
	5.732		0.018	0.013	0.020	0.015	0.008		0.013	0.001		0.016
	5.740		0.002	0.002	0.002	0.014	0.003	0.005	0.042		0.014	0.006
	5.761		0.014	0.010	0.023	0.016	0.012	0.023	0.036	0.001	0.012	0.013
N		3	7	7	7	7	7	3	7	6	6	7
Mean		0.029	0.012	0.008	0.023	0.012	0.009	0.016	0.026	0.001	0.012	0.009
S.D.		0.002	0.005	0.003	0.018	0.005	0.004	0.019	0.011	0.000	0.002	0.004
	6.513	0.039	0.013	0.012	0.031				0.024	0.002	0.011	0.009
	6.549	0.031	0.024	0.022	0.075	0.018	0.031	0.020	0.042	0.004	0.029	0.013
	6.556	0.070	0.022	0.032	0.058	0.065	0.029		0.036	0.004	0.034	0.026
	6.561	0.052	0.029	0.037	0.022	0.016	0.010		0.069	0.006	0.034	0.030
	6.628	0.054	0.048	0.034	0.056		0.024	0.014	0.034	0.004	0.031	0.023
	6.689		0.015	0.018	0.025	0.006	0.020		0.060	0.008	0.006	0.007
	6.711		0.023	0.028	0.057	0.030	0.023		0.034	0.004	0.016	0.022
	6.718		0.019	0.018	0.045	0.028	0.016		0.034	0.005	0.021	0.011
	6.791	0.033	0.039	0.028	0.066	0.025	0.029		0.036	0.003	0.027	0.024
N		6	9	9	9	7	8	2	9	9	9	9
Mean		0.046	0.025	0.025	0.048	0.026	0.022	0.017	0.041	0.004	0.023	0.018
S.D.		0.014	0.011	0.008	0.018	0.018	0.007	0.004	0.014	0.001	0.010	0.008
	7.508	0.092	0.064	0.051	0.120	0.050			0.294	0.008		0.068
	7.583	0.073	0.034	0.051	0.052	0.041	0.040		0.063	0.007	0.026	0.025
	7.606	0.179	0.121	0.089	0.220	0.119	0.100		0.120		0.061	0.072
	7.661	0.050	0.019	0.023	0.128	0.012	0.022			0.007	0.022	0.024
	7.722		0.040	0.069	0.105	0.139	0.048	0.031	0.089	0.006	0.060	0.063
	7.761		0.055	0.078	0.247	0.091	0.078		0.066	0.013	0.070	0.056
	7.798		0.050	0.057	0.188	0.070	0.053		0.132	0.009	0.052	0.053
	7.884		0.089	0.062	0.071	0.049	0.027		0.128	0.016	0.022	0.116
N		4	8	8	8	8	7	1	7	7	7	8
Mean		0.098	0.059	0.059	0.141	0.071	0.052	0.031	0.127	0.009	0.044	0.059
S.D.		0.056	0.032	0.020	0.069	0.042	0.027		0.078	0.003	0.020	0.029

Table 20. LINEAR REGRESSION ANALYSIS OF TISSUE RADIOACTIVITY IN THE NEONATE SQUIRREL MONKEY

	Slope	LCL*	UCL†	Y-intercept	LCL*	UCL†
Brain	0.531	0.486	0.575	0.066	- 0.023	0.157
Liver	0.487	0.454	0.521	0.020	- 0.049	0.090
Kidney	0.489	0.441	0.538	0.002	- 0.097	0.101
Adrenal	0.373	0.321	0.425	0.022	- 0.084	0.130
Spleen	0.322	0.270	0.375	0.045	- 0.063	0.153
GIT	0.318	0.271	0.364	0.046	- 0.046	0.139
Placenta	0.386	0.305	0.466	0.043	- 0.094	0.181
Skin	0.538	0.492	0.584	- 0.023	- 0.115	0.069
Blood	0.513	0.479	0.546	- 0.067	- 0.137	0.002
Muscle	0.383	0.332	0.434	0.059	- 0.043	0.163
Heart	0.405	0.352	0.458	0.000	- 0.108	0.108

*LCL = Lower 95% confidence limit.

†UCL = Upper 95% confidence limit.

Table 21. DISTRIBUTION OF HISTOLOGIC LESIONS AMONG FULL-TERM NEONATE SQUIRREL MONKEYS

	Group	Adr	Kid	Liv	Lung	Brain	Panc	Jej	Pit	Spl	Tes	Thym	Skin	All
Viable (N = 41)	1	1	0	0	2	0	0	0	0	0	0	0	0	3
	2	0	0	0	1	0	0	0	0	0	0	0	0	1
	3	1	1	1	3	0	1	0	0	1	0	0	0	8
	4	1	0	0	0	0	0	0	0	0	0	0	0	1
	5	0	0	1	1	0	0	0	1	0	0	0	1	4
	6	0	0	0	1	0	0	0	0	0	0	0	0	1
	7	0	0	0	2	0	0	0	1	0	-	0	0	3
	Sum	3	1	2	10	0	1	0	2	1	0	0	1	21
Still (N = 5)	1	0	0	-	1	-	-	0	-	0	-	0	0	1
	2	2	1	1	0	1	-	0	0	0	-	1	0	6
	3	-	-	-	-	-	-	-	-	-	-	-	-	-
	4	1	1	1	0	0	-	1	1	1	1	0	0	7
	5	0	0	0	1	0	0	0	-	-	-	0	0	1
	6	-	-	-	-	-	-	-	-	-	-	-	-	-
	7	-	-	-	-	-	-	-	-	-	-	-	-	-
	Sum	3	2	2	2	1	0	1	1	1	1	1	0	15
All (N = 46)	1	1	0	0	3	0	0	0	0	0	0	0	0	4
	2	2	1	1	1	1	0	0	0	0	0	1	0	7
	3	1	1	1	3	0	1	0	0	1	0	0	0	8
	4	2	1	1	0	0	0	1	1	1	1	0	0	7
	5	0	0	1	2	0	0	0	1	0	0	0	1	5
	6	0	0	0	1	0	0	0	0	0	0	0	0	1
	7	0	0	0	2	0	0	0	1	0	-	0	0	3
	Sum	6	3	4	12	1	1	1	3	2	1	1	1	36

Table 22. BODY DIMENSIONS AND ORGAN WEIGHTS IN NEONATE SQUIRREL MONKEYS BY HTO CONCENTRATION

	Animal Number	Head* (cm)			Body (cm)			Weight (g)						
		P-P	N-O	C-C	Thor	Abdo	Lngth	Body	Brain	Hrt	Adr	Kid	Liv	Spl
	1.542	2.50	4.70	3.20	2.40	2.20	12.10	82.00	11.00	0.45	0.12	0.65	2.10	0.10
	1.546	2.90	4.60	3.20	2.70	2.20	13.30	91.20	8.70	0.90	0.13	0.75	2.25	0.11
	1.641	3.60	5.40	3.30	2.90	2.40	14.40	127.00	14.42	0.66	0.19	0.90	4.36	0.13
	1.800	3.40	5.40	3.30	2.80	2.40	13.70	110.00	15.06	0.56	0.18	0.76	3.64	0.13
	1.813	3.80	5.30	4.00	2.80	2.00	13.20	94.00	14.34	0.56	0.12	0.53	3.01	0.15
	1.852	4.30	5.20	3.10	2.60	2.60	15.00	129.00	16.01	0.98	0.15	0.89	3.17	0.18
N		6	6	6	6	6	6	6	6	6	6	6	6	6
Mean		3.41	5.10	3.35	2.70	2.30	13.61	105.53	13.25	0.68	0.15	0.74	3.08	0.13
S.D.		0.64	0.35	0.32	0.17	0.20	1.01	19.61	2.80	0.20	0.03	0.14	0.85	0.03
	2.503	2.90	4.80	3.40	2.40	2.00	11.90	77.00	13.30	0.42	0.14	0.36	4.30	0.11
	2.545	3.90	5.40	3.00	2.80	2.30	14.20	126.00	16.20	0.76	0.20	0.94	3.59	0.16
	2.656	3.60	4.40	3.40	2.80	2.70	14.00	121.00	15.70	0.70	0.20	0.90	4.70	0.10
	2.685	3.60	5.10	3.80	2.60	1.90	12.60	95.00	14.52	0.56	0.12	0.55	2.72	0.10
	2.692	3.80	5.30	3.70	2.90	2.30	13.60	108.00	15.69	0.64	0.18	0.65	3.62	0.17
	2.717	3.30	4.90	3.40	2.40	1.80	12.80	80.00	14.16	0.42	0.17	0.42	2.48	0.12
	2.737	3.40	4.90	3.30	2.60	2.10	13.20	102.00	14.78	0.67	0.22	0.61	2.65	0.13
	2.819	3.50	5.50	3.70	2.70	2.20	13.40	101.00	14.64	0.55	0.10	0.70	3.22	0.18
N		8	8	8	8	8	8	8	8	8	8	8	8	8
Mean		3.50	5.03	3.46	2.65	2.16	13.21	101.25	14.87	0.59	0.17	0.64	3.41	0.13
S.D.		0.31	0.36	0.26	0.18	0.28	0.76	17.43	0.94	0.13	0.04	0.21	0.80	0.03
	3.719	3.60	5.80	3.90	2.70	2.10	13.60	127.00	15.00	0.80	0.25	0.97	3.46	0.15
	3.747	3.10	5.10	4.40	2.40	1.90	12.40	84.00	13.75	0.47	0.22	0.44	2.84	0.15
	3.764	3.80	5.20	3.10	2.80	2.50	12.90	99.00	14.68	0.57	0.14	0.57	3.57	0.13
	3.805	3.30	4.40	3.80	2.50	2.00	13.80	103.00	14.44	0.58	0.34	0.68	4.91	0.16
N		4	4	4	4	4	4	4	4	4	4	4	4	4
Mean		3.45	5.12	3.80	2.60	2.12	13.17	103.25	14.46	0.60	0.23	0.66	3.69	0.14
S.D.		0.31	0.57	0.53	0.18	0.26	0.64	17.82	0.53	0.13	0.08	0.22	0.87	0.01
	4.640	3.50	5.20	4.00	2.90	2.20	14.00	116.00	16.25	0.88	0.26	0.74	6.05	0.18
	4.686	3.60	5.30	3.20	3.00	2.90	13.70	119.00	16.10	0.91	0.40	1.00	4.10	0.30
	4.688	3.00	5.20	3.40	2.80	2.40	13.30	106.40	15.20	0.70	0.20	0.90	3.30	0.20
	4.702	3.60	4.90	3.60	2.70	2.10	13.30	96.00	14.51	0.58	0.17	0.62	2.86	0.15
N		4	4	4	4	4	4	4	4	4	4	4	4	4
Mean		3.42	5.15	3.55	2.85	2.40	13.57	109.35	15.51	0.77	0.25	0.81	4.07	0.20
S.D.		0.28	0.17	0.34	0.13	0.35	0.34	10.39	0.81	0.16	0.10	0.16	1.41	0.06
	5.500	3.80	5.00	3.50	2.80	2.20	13.30	105.00	15.40	0.65	0.11	0.67	3.10	0.13
	5.575	3.60	5.40	3.10	3.10	2.50	13.70	114.00	16.50	0.75	0.20	0.85	3.35	0.25
	5.693	3.50	5.00	3.60	2.40	2.10	12.40	97.00	14.85	0.65	0.25	0.60	3.60	0.20
	5.696	3.60	5.20	3.70	2.70	2.20	14.00	112.00	13.85	0.69	0.20	0.81	3.73	0.14
	5.732	3.60	5.20	3.70	2.60	3.20	13.10	98.00	15.00	0.70	0.40	0.70	2.70	0.25
	5.740	2.90	5.00	2.80	1.80	1.60	12.70	98.00	14.10	0.75	0.50	0.85	4.20	0.30
	5.761	3.90	5.10	3.20	2.80	2.30	13.40	117.00	15.84	0.74	0.35	0.71	3.34	0.11
N		7	7	7	7	7	7	7	7	7	7	7	7	7
Mean		3.55	5.12	3.37	2.60	2.30	13.22	105.85	15.07	0.70	0.28	0.74	3.43	0.19
S.D.		0.32	0.14	0.34	0.41	0.48	0.55	8.47	0.93	0.04	0.13	0.09	0.47	0.07
	6.515	2.60	4.60	3.00	2.50	2.30	11.80	94.00	14.40	0.60	0.20	0.65	3.20	0.20
	6.549	3.30	5.40	3.40	2.80	2.60	13.50	111.90	13.60	0.80	0.25	0.70	2.70	0.04
	6.556	3.60	5.20	3.90	2.50	2.00	13.90	107.00	15.24	0.74	0.16	0.61	3.06	0.11
	6.561	3.50	5.40	3.20	3.10	2.70	13.60	125.00	15.74	0.76	0.20	0.70	4.88	0.12
	6.628	3.10	4.70	3.40	2.50	2.10	12.80	89.00	14.70	0.60	0.30	0.70	2.50	0.20
	6.689	3.70	5.20	3.40	2.90	2.20	12.80	110.00	14.54	0.62	0.13	0.65	3.73	0.14
	6.711	2.90	4.00	3.40	2.70	2.10	12.60	88.00	13.93	0.52	0.14	0.47	2.68	0.15
	6.718	3.90	5.70	3.60	2.80	2.20	13.20	126.00	16.67	0.68	0.11	0.74	3.56	0.10
	6.791	3.00	4.80	2.90	1.50	1.90	12.20	80.00	13.68	0.60	0.30	0.60	2.30	0.20
N		9	9	9	9	9	9	9	9	9	9	9	9	9
Mean		3.28	5.00	3.35	2.58	2.23	12.93	103.43	14.72	0.65	0.19	0.64	3.17	0.14
S.D.		0.42	0.52	0.30	0.45	0.26	0.68	16.53	1.01	0.09	0.07	0.08	0.79	0.05
	7.508	3.20	5.20	3.40	2.60	2.00	13.40	95.70	14.80	0.50	0.15	0.70	2.65	0.15
	7.585	3.40	5.10	3.20	2.90	2.50	14.00	114.00	13.50	0.95	0.17	0.66	3.76	0.13
	7.606	3.80	5.30	3.20	2.90	2.50	13.50	103.00	15.24	0.59	0.13	0.48	3.76	0.09
	7.661	3.60	5.10	3.60	3.10	2.40	13.40	124.00	15.20	0.66	0.10	0.86	3.66	0.17
	7.722	3.50	4.90	3.00	2.40	2.10	13.20	103.00	13.05	0.68	0.12	0.55	2.82	0.09
	7.763	3.60	5.10	3.10	3.00	2.40	12.60	113.00	14.00	0.67	0.10	0.55	2.25	0.10
	7.798	3.20	5.10	3.40	2.70	2.20	13.20	105.00	14.74	0.47	0.10	0.70	3.28	0.14
	7.884	3.30	5.00	3.00	1.60	2.10	12.70	88.20	12.40	0.50	0.10	0.50	2.50	0.10
N	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Mean		3.45	5.04	3.23	2.65	2.27	13.25	105.74	14.11	0.63	0.11	0.63	3.08	0.12
S.D.		0.21	0.13	0.20	0.48	0.19	0.46	11.20	1.04	0.16	0.02	0.12	0.60	0.03

*P-P = parietal width; N-O = nose to occiput; C-C = chin to crown.

Table 23. BODY DIMENSIONS AND ORGAN WEIGHTS OF MALE NEONATE SQUIRREL MONKEYS

Animal Number	Head* (cm)			Body (cm)			Weight (g)						
	P-P	N-O	C-C	Thor	Abdo	Lngth	Body	Brain	Hrt	Adr	Kid	Liv	Spl
1.546	2.90	4.60	3.20	2.70	2.20	13.30	91.20	8.70†	0.90	0.13	0.75	2.25	0.11
1.641	3.60	5.40	3.30	2.90	2.40	14.40	127.00	14.42	0.66	0.19	0.90	4.36	0.13
1.852	4.30	5.20	3.10	2.60	2.60	15.00	129.00	16.01	0.98	0.15	0.89	3.17	0.18
2.545	3.90	5.40	3.00	2.80	2.30	14.20	126.00	16.20	0.76	0.20	0.94	3.59	0.16
2.656	3.60	4.40	3.40	2.80	2.70	14.00	121.00	15.70	0.70	0.20	0.90	4.70	0.10
2.692	3.80	5.30	3.70	2.90	2.30	13.60	108.00	15.69	0.64	0.18	0.65	3.62	0.17
3.719	3.60	5.80	3.90	2.70	2.10	13.60	127.00	15.00	0.80	0.25	0.97	3.46	0.15
3.747	3.10	5.10	4.40	2.40	1.90	12.40	84.00	13.75	0.47	0.22	0.44	2.84	0.15
4.640	3.50	5.20	4.00	2.90	2.20	14.00	116.00	16.25	0.88	0.26	0.74	6.05	0.18
4.686	3.60	5.30	3.20	3.00	2.90	13.70	119.00	16.10	0.91	0.40	1.00	4.10	0.30
4.688	3.00	5.20	3.40	2.80	2.40	13.30	106.40	15.20	0.70	0.20	0.90	3.30	0.20
4.702	3.60	4.90	3.60	2.70	2.10	13.30	96.00	14.51	0.58	0.17	0.62	2.86	0.15
5.500	3.80	5.00	3.50	2.80	2.20	13.30	105.00	15.40	0.65	0.11	0.67	3.10	0.13
5.575	3.60	5.40	3.10	3.10	2.50	13.70	114.00	16.50	0.75	0.20	0.85	3.35	0.25
5.732	3.60	5.20	3.70	2.60	3.20	13.10	98.00	15.00	0.70	0.40	0.70	2.70	0.25
6.549	3.30	5.40	3.40	2.80	2.60	13.50	111.90	13.60	0.80	0.25	0.70	2.70	0.04
6.561	3.50	5.40	3.20	3.10	2.70	13.60	125.00	15.74	0.76	0.20	0.70	4.88	0.12
6.628	3.10	4.70	3.40	2.50	2.10	12.80	89.00	14.70	0.60	0.30	0.70	2.50	0.20
6.689	3.70	5.20	3.40	2.90	2.20	12.80	110.00	14.54	0.62	0.13	0.65	3.73	0.14
6.718	3.90	5.70	3.60	2.80	2.20	13.20	126.00	16.67	0.68	0.11	0.74	3.56	0.10
6.791	3.00	4.80	2.90	1.50	1.90	12.20	80.00	13.68	0.60	0.30	0.60	2.30	0.20
N	21	21	21	21	21	21	21	21	21	21	21	21	21
Mean	3.52	5.17	3.44	2.63	2.73	13.47	109.97	14.92	0.72	0.21	0.76	3.48	0.16
S.D.	0.35	0.34	0.35	0.53	0.33	0.64	15.30	1.69	0.12	0.08	0.14	0.93	0.05

*P-P = parietal width; N-O = nose to occiput; C-C = chin to crown.

†This animal was found dead on pen floor. At necropsy, contusions and herniation of the brain through a skull fracture were observed.

Table 24. BODY DIMENSIONS AND ORGAN WEIGHTS OF FEMALE NEONATE SQUIRREL MONKEYS

Animal Number	Head* (cm)			Body (cm)			Weight (g)						
	P-P	N-O	C-C	Thor	Abdo	Lngth	Body	Brain	Hrt	Adr	Kid	Liv	Spl
1.542	2.50	4.70	3.20	2.40	2.20	12.10	82.00	11.00	0.45	0.12	0.65	2.10	0.10
1.800	3.40	5.40	3.30	2.80	2.40	13.70	110.00	15.06	0.56	0.18	0.76	3.64	0.13
1.813	3.80	5.30	4.00	2.80	2.00	13.20	94.00	14.34	0.56	0.12	0.53	3.01	0.15
2.503	2.90	4.80	3.40	2.40	2.00	11.90	77.00	13.30	0.42	0.14	0.36	4.30	0.11
2.685	3.60	5.10	3.80	2.60	1.90	12.60	95.00	14.52	0.56	0.12	0.55	2.72	0.10
2.717	3.30	4.90	3.40	2.40	1.80	12.80	80.00	14.16	0.42	0.17	0.42	2.48	0.12
2.737	3.40	4.90	3.30	2.60	2.10	13.20	102.00	14.78	0.67	0.22	0.61	2.65	0.13
2.819	3.50	5.50	3.70	2.70	2.20	13.40	101.00	14.64	0.55	0.10	0.70	3.22	0.18
3.764	3.80	5.20	3.10	2.80	2.50	12.90	99.00	14.68	0.57	0.14	0.57	3.57	0.13
3.805	3.30	4.40	3.80	2.50	2.00	13.80	103.00	14.44	0.58	0.34	0.68	4.91	0.16
5.693	3.50	5.00	3.60	2.40	2.10	12.40	97.00	14.85	0.65	0.25	0.60	3.60	0.20
5.696	3.60	5.20	3.70	2.70	2.20	14.00	112.00	13.85	0.69	0.20	0.81	3.73	0.14
5.740	2.90	5.00	2.80	1.80	1.60	12.70	98.00	14.10	0.75	0.50	0.85	4.20	0.30
5.761	3.90	5.10	3.20	2.80	2.30	13.40	117.00	15.84	0.74	0.35	0.71	3.34	0.11
6.515	2.60	4.60	3.00	2.50	2.30	11.80	94.00	14.40	0.60	0.20	0.65	3.20	0.20
6.556	3.60	5.20	3.90	2.50	2.00	13.90	107.00	15.24	0.74	0.16	0.61	3.06	0.11
6.711	2.90	4.00	3.40	2.70	2.10	12.60	88.00	13.93	0.52	0.14	0.47	2.68	0.15
7.508	3.20	5.20	3.40	2.60	2.00	13.40	95.70	14.80	0.50	0.15	0.70	2.65	0.15
7.585	3.40	5.10	3.20	2.90	2.50	14.00	114.00	13.50	0.95	0.17	0.66	3.76	0.13
7.606	3.80	5.30	3.20	2.90	2.50	13.50	103.00	15.24	0.59	0.13	0.48	3.76	0.09
7.661	3.60	5.10	3.60	3.10	2.40	13.40	124.00	15.20	0.66	0.10	0.86	3.66	0.17
7.722	3.50	4.90	3.00	2.40	2.10	13.20	103.00	13.05	0.68	0.12	0.55	2.82	0.09
7.763	3.60	5.10	3.10	3.00	2.40	12.60	113.00	14.00	0.67	0.10	0.55	2.25	0.10
7.798	3.30	5.10	3.40	2.70	2.20	13.20	105.00	14.74	0.47	0.10	0.70	3.28	0.14
7.884	3.30	5.00	3.00	1.60	2.10	12.70	88.20	12.40	0.50	0.10	0.50	2.50	0.10
N	25	25	25	25	25	25	25	25	25	25	25	25	25
Mean	3.36	5.00	3.38	2.58	2.15	13.05	100.07	14.24	0.60	0.17	0.62	3.24	0.13
S.D.	0.36	0.32	0.31	0.33	0.22	0.62	11.62	1.01	0.12	0.09	0.12	0.68	0.04

*P-P = parietal width; N-O = nose to occiput; C-C = chin to crown.

Table 25. HEMATOLOGIC PARAMETERS OF NEONATE SQUIRREL MONKEYS

Animal Number	RBC ($\times 10^{-6}$)	Hgb (g %)	Hct (%)	MCV (μ^3)	MCH ($\mu\mu g$)	MCHC (%)	WBC ($\times 10^{-3}$)	Neut (%)	Band (%)	Lymp (%)	Mono (%)	Eos (%)	Base (%)
1.542	4.70	16.30	46.30	98.00	34.60	35.10	9.90	56.00	6.00	32.00	5.00	1.00	
1.800	6.45	19.40	55.50	85.00	30.10	35.00	3.70	69.00	3.00	23.00	4.00	1.00	
1.813	5.88	18.30	52.20	87.00	31.00	35.00	6.90	50.00	2.00	45.00	1.00	2.00	
1.852	5.61	18.80	53.30	93.00	33.10	34.90	9.30	67.00	1.00	30.00	1.00	1.00	
2.545	5.54	17.70	50.60	91.00	31.80	34.80	7.30	76.00	6.00	12.00	6.00		
2.692	5.40	17.70	50.90	93.00	32.80	34.80	8.70	80.00	2.00	18.00			
2.717	6.19	19.20	54.60	88.00	31.00	35.20	7.30	80.00	5.00	10.00	2.00	2.00	1.00
2.737	6.41	19.90	57.70	90.00	31.00	34.40	10.80	66.00		31.00	2.00	1.00	
2.819	3.76	10.80	31.80	82.00	28.50	33.90	3.00	73.00		22.00	5.00		
3.719	6.74	20.50	57.50	85.00	30.30	35.50	5.90	51.00		47.00		2.00	
3.747	5.88	17.70	52.30	88.00	30.20	33.90	6.40	63.00	2.00	33.00	2.00		
4.686	7.28	22.20	63.40	87.00	30.40	34.90	11.50	70.00	2.00	27.00			1.00
4.688	6.06	19.30	56.10	92.00	31.80	34.40	10.20	52.00	1.00	45.00	2.00		
5.575	5.55	16.40	48.60	87.00	29.50	33.70	8.00	75.00		12.00	5.00	8.00	
5.693	5.93	18.50	53.00	89.00	31.70	35.40	7.40	81.00	1.00	19.00			
5.696	6.21	17.90	52.10	83.00	28.80	34.30	6.20	63.00		37.00			
5.732	6.11	18.10	51.00	83.00	29.60	35.60	5.20	67.00		32.00	1.00		
5.761	6.53	19.00	55.70	85.00	29.10	34.10	5.80	77.00		23.00			
6.515	6.41	18.30	52.70	82.00	28.90	35.10	8.20	67.00		33.00			
6.549	5.94	19.00	53.40	90.00	31.60	35.10	8.40	70.00	2.00	20.00		8.00	
6.556	4.39	13.60	39.50	89.00	31.00	34.50	4.30	70.00	1.00	25.00	2.00	2.00	
6.561	5.97	17.30	50.80	85.00	28.90	34.00	4.90	61.00	1.00	37.00		1.00	
6.689	6.72	20.80	59.50	88.00	30.90	34.90	6.30	73.00	1.00	12.00	3.00	10.00	1.00
6.711	4.03	12.30	34.50	84.00	30.50	35.70	3.40	54.00	2.00	43.00	1.00		
6.718	5.32	16.10	46.70	87.00	30.30	34.50	5.50	80.00		10.00	5.00	2.00	3.00
6.791	4.65	15.20	43.40	92.00	32.70	35.00	3.90	76.00	2.00	18.00	3.00		1.00
7.585	6.57	19.20	55.80	85.00	29.20	34.40	8.80	74.00	2.00	22.00	2.00		
7.606	5.88	18.50	51.80	87.00	31.40	35.60	7.80	45.00		54.00		1.00	
7.661	5.87	17.30	51.00	86.00	29.90	34.40	5.00	56.00		43.00			1.00
7.763	5.70	17.30	49.30	86.00	30.30	35.10	3.90	85.00		10.00	4.00	1.00	
7.798	6.43	18.30	54.40	84.00	28.40	33.60	6.50	73.00		25.00	2.00		
7.884	5.25	17.30	49.80	92.00	32.80	34.80	5.70	39.00		59.00	2.00		
N	32	32	32	32	32	32	32	32	32	32	32	32	32
Mean	5.79	17.75	51.10	87.59	30.69	34.73	6.75	66.84	1.31	28.40	1.88	2.87	0.25
S.D.	0.80	2.31	6.56	3.69	1.48	0.56	2.23	11.44	1.69	13.32	1.88	3.07	0.62

Table 26. SEROLOGIC PARAMETERS OF NEONATE SQUIRREL MONKEYS

	Animal Number				
	5.575	6.515	6.549	7.585	7.661
Glucose (mg%)	140	302	87	216	138
BUN (mg%)	24	26	27	35	18
Creatinine (mg%)	0.8	1.1	1.2	1.2	0.9
Uric acid (mg%)	0	0.7	0.8	1.7	0
Na^+ (meq/1)	141	146	150	148	146
K^+ (meq/1)	3.5	5.6	3.4	5.6	4.1
CO_2 (meq/1)	16	17	22	15	14
Cl^- (meq/1)	101	96	100	107	109
Calcium (mg%)	11.3	11.0	10.2	11.8	10.2
Phosphorus (mg%)	3.2	4.6	5.0	5.0	4.8
Balance (5-7-8) (meq/1)	24	33	28	26	23
Cholesterol (mg%)	334	313	225	269	331
Triglycerides (mg%)	43	32	40	246	13
Bilirubin (Tot) (mg%)	8.4	13.6	9.7	9.4	8.7
SGOT (mU/ml)	143	152	238	372	96
SGPT (mU/ml)	33	3	24	46	14
LDM (mU/ml)	263	342	371	1060	415
Alk. phos. (mU/ml)	1410	1810	1870	2490	1845
Iron (Tot) (mcg%)	69	41	54	65	149
Protein (Tot) (g%)	4.9	5.4	4.6	5.4	5.0
Albumin (g%)	4.4	5.1	4.3	4.9	4.5
Globulin (g%)	0.5	0.3	0.3	0.5	0.5
A/G (g%)	8.80	17.00	14.33	9.80	9.00
Bilirubin (Dir) (mg%)	0.2	--	--	--	--

REFERENCES

1. D. J. Kimeldorf and E. L. Hunt. Ionizing radiation and neural development (Ch. 3). In Ionizing Radiation: Neural Function and Behavior. Academic Press, New York, 1976.

2. U.S. Nuclear Regulatory Commission, Title 10, Code of Federal Registry, Part 20, Appendix B, 30 May 75.

3. W. W. Tullner and R. Hertz. Chorionic gonadotrophin levels in the Rhesus monkey during early pregnancy. Endocrinology 78, 204-207 (1966).

4. J. G. Wilson and R. Fradkin. Teratogeny in nonhuman primates, with notes on breeding procedures in Macacca mulatta. Ann. N.Y. Acad. Sci. 162, 267-277 (1969).

5. T. H. Clewe. Observations on reproduction of squirrel monkeys in captivity. J. Reprod. Fertil. (Suppl.) 6, 151-156 (1969).

6. C. M. Goss, L. T. Popejoy, J. L. Fusiler, and T. M. Smith. Observations on the relationship between embryological development, time of conception, and gestation (Ch. 6). In The Squirrel Monkey. L. A. Rosenblum and R. W. Cooper (eds.), Academic Press, New York, 1968.

7. D. F. Cahill and C. L. Yuile. Tritium: Some effects of continuous exposure in utero on mammalian development. Radiat. Res. 44, 727-737 (1970).

8. R. L. Dobson and C. T. Kwan. The RBE of tritium radiation measured in mouse oocytes: Increase at low exposure levels. Radiat. Res. 66, 615-625 (1976).

9. R. L. Dobson and M. F. Cooper. Tritium toxicity: Effects of low-level ^{3}HOH exposure on developing female germ cells in the mouse. Radiat. Res. 58, 91-100 (1974).

10. L. M. Ausman, D. L. Gallina, K. C. Hayes, and D. M. Hegsted. Hematological development of the infant squirrel monkey (Saimiri sciureus). Folia Primatol. 26, 292-300 (1976).

11. A. E. New. App. Base-line blood determinations of the squirrel monkey (Saimiri sciureus). Appendix to The Squirrel Monkey. L. A. Rosenblum and R. W. Cooper (eds.), Academic Press, New York, 1968.

12. P. J. Manning, N.D.M. Lehner, M. A. Feldner, and B. C. Bullock. Selected hematologic, serum chemical, and arterial blood gas characteristics of squirrel monkeys (Saimiri sciureus). Lab. Animal Care 19, 831-837 (1969).

13. C. M. Lang. The laboratory care and clinical management of Saimiri (squirrel monkeys) (Ch. 14). In The Squirrel Monkey. L. A. Rosenblum and R. W. Cooper (eds.), Academic Press, New York, 1968.

14. C. C. Middleton and J. Rosal. Weights and measurements of normal squirrel monkeys. Lab. Animal Sci. 22, 583-585 (1972).

15. K. Capel-Edwards and D. E. Hall. Haemotological observations on the squirrel monkey. Folia Primatol. 12, 142-160 (1970).